Assessing Mobile Learning Effectiveness and Acceptance

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Assessing Mobile Learning Effectiveness and Acceptance

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Dedication

The author wishes to thank Phillip Merrill – Thank you for reminding me of my audience.

Acknowledgments

The author wishes to acknowledge all those who helped make this journey successful . . .

there were many footprints in the sand.

Abstract of Dissertation

Assessing Mobile Learning Effectiveness and Acceptance

There is a time and place for learning; it should be a learner's time and place.[1]

– Siobhan Thomas, *Pervasive, Persuasive eLearning*

The justification of mobile learning comes from the 'law' of distance education research which states that, 'It is not technologies with inherent pedagogical qualities that are successful in distance education, but technologies that are generally available to citizens.'[2]

– Desmond Keegan, *Mobile Learning: A Practical Guide*

About 3.5 million students in post-secondary education are taking at least one online course, according to The 2007 Sloan Survey of Online Learning, which involved more than 2,500 colleges and universities in the United States. This represents a nearly 10 percent increase from last year's study, which found 3.18 million online learners nationwide.[3]

'There are variants of what 'access' means, but all higher education institutions — even those that don't have online courses — overwhelmingly believe that online programs serve an audience that is not well served by classic face-to-face programs,' said Jeff Seaman, survey director for The Sloan Consortium. The number-one driving factor is that there are people out there who want an education, but the traditional method of driving to a campus and sitting in class just doesn't work for them.[4]

– Brian Summerfield, *One Out of Five Higher Ed Students Takes Online Courses*

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1. Siobhan Thomas, "Pervasive, Persuasive eLearning: Modeling the Pervasive Learning Space," (proceedings of the 3rd International Conference on Pervasive Computing and Communications Workshops, Kauai, Hawaii 2005, 332-336), IEEE Computer Society, under "Locationality," http://ieeexplore.ieee.org/iel5/9593/30313/01392860.pdf (accessed May 13, 2007).

2. Desmond Keegan, "Mobile Learning; A Practical Guide," http://www.ericsson.com/ericsson/corpinfo/programs/incorporating_mobile_learning_into_mainstream_education/products/book/introduction.pdf (accessed September 21, 2007).

3. Brian Summerfield, "One Out of Five Higher Ed Students Takes Online Courses," *Chief Learning Officer*, October 2007, http://www.clomedia.com/executive-briefings/2007/October/1972/index.php (accessed July 15, 2007).

4. Ibid.

The purpose of this study was to assess Mobile Learning (M-Learning) effectiveness vis-à-vis Face-to-Face Learning and to determine the extent to which students used and accepted the M-Learning education delivery methodology. Two research models were employed: 1) a Performance Model, and 2) the Unified Theory of Acceptance and Use of Technology Model (UTAUT).[5]

These models were used two answer two research questions:

1. Is the M-Learning Mode of Delivery (MOD) more or less effective than FTF?

2. What are the factors that influence the acceptance and use of M-Learning?

Participants in the Control group (Face-to-Face) outperformed Treatment group participants (M-Learning) on both of two quizzes administered during the study. Face-to-Face participants performed significantly better (9 %) in average performance than M-Learning participants on the first quiz (p=.000; Adjusted R^2 =.106). Similarly, Face-to-Face participants significantly outperformed M-Learning Mode of Delivery participants by 7% (p=.010; Adjusted R^2=.052) on the second quiz. The average increase in performance across both quizzes was 8%.

Other than mode of delivery (Face-to-Face or M-Learning), the factors that influenced the acceptance and use of M-Learning were not determined; UTAUT, adapted specifically to measure M-Learning acceptance and use, did not provide as much insight into the M-Learning environment as it had when applied to other technology contexts.

5. Viswanath Venkatesh, et al., "User Acceptance of Information Technology: Toward A Unified View" *MIS Quarterly* 27, no. 3 (September 2003).

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Chapter 1 Introduction

1.1 The Research

The purpose of this study was to assess Mobile Learning (M-Learning) effectiveness vis-à-vis Face to Face Learning (FTF) and to determine the extent to which students accepted the M-Learning education delivery methodology.

A gap existed in the body of scholarly literature regarding M-Learning; although many M-Learning pilot and fully-implemented projects existed, there remained a dearth of media comparison studies (MCS)[6] that compared them to FTF.[7] This study was important because it addressed this literature gap through a comparison of the effectiveness of the burgeoning M-Learning paradigm versus FTF. The study also contributed to the body of scholarly literature that examined user acceptance of M-Learning.

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6. "In these studies, researchers look to compare student outcomes for two courses that are delivered through two different methods, thereby identifying the "superior" method for teaching effectiveness." WCET, the Cooperative Advancing the Effective use of Technology in Higher Education, "Frequently Asked Questions," under "What is the "No Significant Difference Phenomenon?" http://nosignificantdifference.wcet.info/faq.asp#Q7 (accessed February 25, 2008).

7. Barbara B. Lockee, John K. Burton, and Lawrence H. Cross, "No Comparison: Distance Education Finds a New Use for 'No Significant Difference'," *Educational Technology, Research and Development* 47, no. 3 (1999): 465-471; Thomas L. Russell, *The No Significant Difference Phenomenon* (Montgomery, AL: IDECC, 2001).

M-Learning is not a novelty. It is a mainstream, pervasive learning delivery medium relied upon by thousands of post-secondary education institutions and millions of workforce and distance-educated students worldwide.[8]

Prior to this study, a plethora of media comparison studies comparing Distance Learning (D-Learning) and Electronic Learning (E-Learning) strategies[9] and *learning objects* versus FTF had been conducted.[10]

Cobcroft, et al. and Dray describe Learning Objects as ". . . any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning."[11]

8. U.S. Department of Education, National Center for Education Statistics, Postsecondary Education Quick Information System, "Survey on Distance Education at Higher Education Institutions, 2001 – 2002," (2002 – most recent data available), http://nces.ed.gov/surveys/peqis/inc/displaytables_inc.asp (accessed November 7, 2007).

9. Ryan Watkins, and Michael Corry, *E-Learning Companion: A Student's Guide to Online Success* (New York: Houghton Mifflin, 2005); Susan Ko and Steven Rossen, *Teaching Online: A Practical Guide* (Boston: Houghton Mifflin, 2004).

10. Thomas L. Russell, *The No Significant Difference Phenomenon*; WCET, "No Significant Difference," under "No Significant Difference Phenomenon," http://www.nosignificantdifference.org/ (accessed November 12, 2006).

11. Rachel Cobcroft, Stephen Towers, Jude Smith, and Axel Bruns, "Literature Review into Mobile Learning in the University Context," http://eprints.qut.edu.au/archive/00004805/01/4805.pdf (accessed August 28, 2007); Dray, "The Learning Object Metadata Standard," IEEE Learning Technology Standards Committee, http://www.ieeeltsc.org/working-groups/wg12LOM/lomDescription/ (accessed November 19, 2007).

Examples of Learning Objects include:[12]

1. Instructional content
2. Instructional software and software tools
3. Multimedia content
4. Persons, organizations, or events referenced during technology supported learning

Historically, electronic learning objects (virtual 'courseware'), were designed and developed specifically for playback on unique devices, e.g. videotapes, cassette tapes, CDs, television, personal computers, etc.[13] Accessing courseware specifically developed for these electronic devices resulted in a tethered learning approach, restricting the ability of mobile students to take courses. M-Learning, as a subset of D- and E-Learning, was designed to overcome such limitations (see figure 1.1).

12. Ibid.

13. Lockee, Burton, and Cross, "No Comparison," 304.

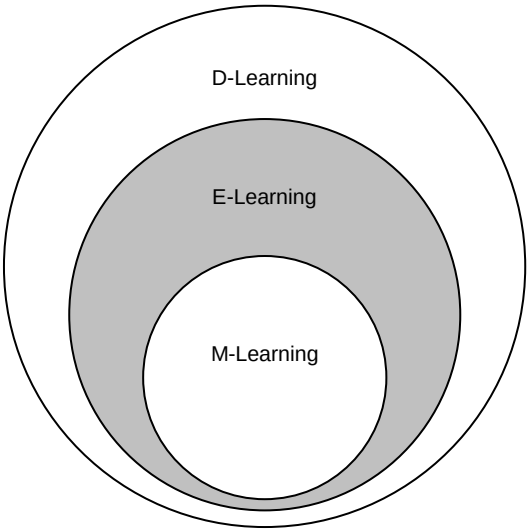

Figure 1.1. The Place of M-Learning as Part of E-Learning and D-Learning. *Source:* Tsvetozar Georgiev, Evgenia Georgieva, and Angel Smrikarov, "M-learning – a New Stage of E-Learning" (paper presented at the International Conference on Computer Systems and Technologies – CompSysTech, Rousse, Bulgaria, June 17-18, 2004): IV.28-1, fig. 1, http://ldt.stanford.edu/~educ39106/articles/m-learning.pdf (accessed August 1, 2007).

M-Learning: 1) provides the ability to create homogenous learning objects for heterogeneous mobile devices, and 2) does so by utilizing wireless connectivity. This approach benefits a growing audience of post-secondary institution and workforce learners, e.g. those in hard to reach, isolated locations, away from their home or office, or in FTF environments where a need to augment the classroom experience exists. The advent of M-Learning created an environment of anywhere, anytime learning.[14]

14. Cobcroft, Towers, Smith, and Bruns, "Literature Review"; Emily Hollis, "M-Learning; The Next Wave for Training and Development," *Chief Learning Officer*, March 2004, http://www.clomedia.com/content/templates/clo_article.asp?articleid=429&zoneid=101 (accessed August 30, 2007); Ellen Wagner, "Mobile Learning: The Next Step in Technology-Mediated Learning," *Chief Learning Officer*, February 2007, under "The Changing Nature of Learning," http://www.clomedia.com/content/templates/clo_article.asp?articleid=1686&zoneid=77 (accessed August 28, 2007).

1.2 Preface

As the number of distance students continues to rise[15] – e.g. military personnel stationed overseas, workers in isolated locations, stay-at-home parents, disabled persons, and traditional students with a desire to augment their FTF experience, etc. – a proportionate increase in the demand for courseware targeted at distance learners has occurred.[16]

M-Learning research and development efforts continue to move rapidly, ostensibly to create a learning environment that can keep pace with the demand of mobile learners who regularly use small *information appliances*[17] to access multimedia content. The result of these efforts is a platform that delivers course content available for playback at a time and place convenient to students.

Post-secondary education institutions and private sector firms can take advantage of this platform. This can be achieved by using commonly-available multimedia development software to format learning objects for the mobile information appliances now commonplace in the book bags and briefcases of most students. The act of accessing

15. International Data Corporation, "Online Distance Learning in Higher Education, 1998-2002," most recent data available, quoted in Council for Higher Education, "Distance Learning in Higher Education: An Ongoing Study on Distance Learning in Higher Education Prepared for CHEA by the Institute for Higher Education Policy," http://www.chea.org/Research/distance-learning/distance-learning-2.htm (accessed June 30, 2007).

16. Ibid.

17. ". . . [devices] that focuses on handling a particular type of information and related tasks" – iPods, PDAs, cell phones, mobile phones, and smart phones, etc.; W3 Consortium, "Compact HTML for Small Information Appliances," http://www.w3.org/TR/1998/NOTE-compactHTML-19980209/ (accessed September 20, 2007).

course content via these appliances is the primary distinguishing characteristic between M-, E-, and D-Learning.

Information appliances provide the ability for students to work untethered from a distance and are capable of capturing a variety of course materials in a variety of formats, e.g. audio, video, text, etc. The growing library of educational content designed for information appliances has situated M-Learning ". . . clearly in the future of learning."[18]

Standards for the development, delivery, and translation of multimedia objects have existed for over a decade, e.g. MP3 for audio[19], and AVI for video[20]. Unfortunately, media hardware manufacturers lagged, both unintentionally and purposely, (e.g. Beta vs. VHS), in recognizing the need to create objects that can be used *across* media platforms. Instead, proprietary standards were used to create content playable on a particular device: videotapes on VCRs, compact discs on compact disc players, DVDs on televisions, etc. Videotapes could not be played on CD players; CDs could not be played on videotape players, etc.

It was considered both time consuming and a duplication of effort to redesign and redevelop homogenous multimedia objects so they could be played back on a device for

---

18. Desmond Keegan, "The Future of Learning: from eLearning to mLearning," ed. Paul Landers, under "Chapter 3. From eLearning to mLearning – The Arrival of mLearning," http://learning.ericsson.net/mlearning2/project_one/thebook/chapter3.html (accessed June 5, 2007); Keegan, "The Future of Learning," under "Chapter 9. Conclusion – The Future of Learning"; Sonicwall, "Glossary," under "Glossary of Terminology," http://www.aventail.com/tech_support/glossary_k-r.asp (accessed October 12, 2007); Eva Kaplan-Leiserson, "Learning circuits: ASTD's Source for e-Learning," American Society for Training and Development, under "M-Learning," http://www.learningcircuits.org/glossary (accessed September 5, 2007).

19. Mary Bellis, "The History of MP3," under "Timeline – the History of MP3," http://inventors.about.com/od/mstartinventions/a/MPThree.htm (accessed August 29, 2007).

20. "Capture Guides → Introduction to Capturing Video," under "More on the AVI Format," http://www.digitalfaq.com/dvdguides/capture/intro.htm (accessed August 29, 2007).

which they were not originally designed. As time passed, media capable of playing a wide variety of content proliferated, and although the process of developing learning objects for playback on unique devices continued, the results were remarkably different. Audio, video, and text content originally developed for one media could now be played back, unaltered, on a wide variety of players; content originally designed for CDs was no longer restricted to being played on a CD player – the content could just as easily be played back on iPods, PDAs, cell phones, smartphones, etc.

This homogenously developed, heterogeneously consumed content development process brought about a paradigm shift in learning object design, development, and implementation. While instructional content developers and infrastructure designers continued the cost-effective practice of developing objects targeted at one media player, they could now expect the content to be more broadly consumed. In turn, this practice was adopted by universities and firms that wished to reach a diverse audience of learners – many of whom were mobile with restricted access to the devices that traditionally made D- and E-Learning possible.

1.3 Research Questions

> The mobile revolution is finally here. Wherever one looks, evidence of mobile penetration is irrefutable: cell phones, PDAs, MP3 players, portable game devices, handhelds, tablets, and laptops abound. No demographic is immune from this phenomenon. From toddlers to seniors, people are increasingly connected and are digitally communicating with each other in ways that would have been impossible only a few years ago.[21]
>
> – Ellen D. Wagner, *Enabling Mobile Learning*

21. Ellen D. Wagner, "Enabling Mobile Learning," *EDUCAUSE Review*, 40, no. 3, (May/June 2005): 42, http://www.educause.edu/ir/library/pdf/ERM0532.pdf (accessed September 1, 2007).

We have undergone an explosion of M-Learning as a learning medium. This explosion was driven by mobile workforce demand and enabled by the technologies described by Wagner. The question remains, however, as to whether M-Learning is as effective as FTF – the leading contender in the learning environment. FTF is the delivery method that has traditionally been, and will most likely continue to be, the yardstick against which all other learning strategies are measured.

It is therefore important, practical, and prudent to evaluate the new M-Learning paradigm against FTF. This research performed such an evaluation through the use of: 1) a Media Comparison Study (MCS)[22], and 2) a technology acceptance model (UTAUT)[23]. This study specifically addressed the following Research Questions:

1. Is the M-Learning Mode of Delivery (MOD) more or less effective than FTF?
2. What are the factors that influence the acceptance and use of M-Learning?

Beneficiaries of this study include instructors in schools and post-secondary education institutions, as well as trainers in the private sector and workforces in general. As each constituency ponders the implementation of M-Learning projects, they have to take into consideration the effectiveness and acceptance of the strategy. It is equally important to also determine M-Learning profitability and return on investment.[24]

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22. Russell, *The No Significant Difference Phenomenon*.

23. Venkatesh, et al., "User Acceptance of Information Technology".

24. John Traxler, "M-Learning – Evaluating the Effectiveness and Cost," lecture, Learning Lab Conference, June, 2001, http://www.mlearning.org/archive/docs/MLEARN_2003_John_Traxler_presentation_May03.ppt#393,1,m-learning – Evaluating the Effectiveness and the Cost (accessed September 20, 2007).

> The vision is clear. M-Learning is the intersection of mobile computing and E-Learning: accessible resources wherever you are, strong search capabilities, rich interaction, powerful support for effective learning, and performance-based assessment: E-Learning independent of location in time or space. *What is less clear is where we are now and how we will deliver on this vision. Expectations are high due to nearly boundless independency of learning regarding time and space* [emphasis added]. [25]

In order to provide transparency into the strengths and weaknesses of M-Learning, it has become increasingly important to perform rigorous evaluations similar to those undertaken for FTF. If these evaluations are not undertaken, significant time, financial, and other resources will be wasted on what might turn out to be a non-viable learning delivery method.

The usefulness of MCS extends beyond the classroom. In 1997, Circuit City introduced its proprietary DIVX multimedia content platform.[26] The platform afforded free one-time playback of DIVX DVDs before charging for subsequent viewing (tracked through an integrated modem). The format was touted as a replacement to media rental. Similar to M-Learning, it was excitedly introduced as a novel and cool technology format around which a significant buzz was generated.

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25. Donna J. Abernathy, "Get Ready for M-Learning – Mobile Learning – Statistical Data Included," *Training and Development*, February 2001, under "M-Vision," http://findarticles.com/p/articles/mi_m4467/is_2_55/ai_70659640 (accessed July 2, 2007); Clark Quinn, "mLearning: Mobile, Wireless, In-Your-Pocket Learning," *LINE Zine*, Fall 2000, http://www.linezine.com/2.1/features/cqmmwiyp.htm (accessed August 13, 2007); Matthias Meisenberger and Alexander K. Nischelwitzer, "The Mobile Learning Engine (MLE) – A Mobile, Computer-aided, Multimedia-Based Learning Application," (paper presented at the Multimedia Applications in Education Conference, Graz, Austria, September 4-6, 2006), under "Abstract," http://drei.fh-joanneum.at/mle/docs/Matthias_Meisenberger_MApEC_Paper_mLearning.pdf (accessed July 18, 2007).

26. A limited-access DVD technology once promoted by United States electronic retailer Circuit City, http://etvcookbook.org/glossary/ (accessed November 6, 2007); About.com, "Circuit City's DIVX Format Bites the Dust," http://hometheater.about.com/library/weekly/aa062199.htm (accessed November 7, 2007).

DIVX technology was eagerly consumed by early adopters and maintained momentum long enough to be embraced by laggards.[27] Unfortunately, in 1999 the format fizzled and consequently became Not Supported. Consumers were left with unplayable DVDs and a significant loss on investment. Similarly, BETA videotape standards were trumped by VHS, leaving BETA videotape owners with unusable media.[28] In both cases a Media Comparison Study might have helped consumers avoid what turned out to be non-viable technologies.

In contrast, the M-Learning delivery method seems to have overcome the competitive challenge from FTF, inertia, and hype and established itself as a viable contender in the instructional delivery arena. It continues to develop at a rapid clip, utilizing wireless technologies shortly after their introduction and subsequently gaining acceptance by millions of users and hundreds of institutions.[29] It has become a learning object delivery reality which serves learners using ubiquitous mobile devices to attend virtual courses and/or supplement their FTF experiences.

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27. Everett M. Rogers, "New Product Adoption and Diffusion," *Journal of Consumer Research*, 2, March 1976, http://www.jstor.org/view/00935301/di007460/00p0085b/0?frame=noframe&userID=80a4e2f3@gwu.edu/01c0a8486400504b408&dpi=3&config=jstor (accessed November 7, 2007).

28. Mark Chase and Andrew Zinberg, "The Battle Between Beta and VHS," History of American Technology, http://web.bryant.edu/~ehu/h364proj/sprg_98/chase/front.htm (accessed November 7, 2007).

29. Apple Computer Corporation, "iTunes U: The Campus that Never Sleeps," under "Join the Movement," http://www.apple.com/education/itunesu/index.html (accessed July 20, 2007).

An important question remains; as M-Learning proliferates, will it fall into the category of Russell's body of research where a 'No Significant Difference Phenomenon' (NSD)[30] exists? A category where:

> . . . [the] amount of learning produced by different media is similar (NSD) but adequate to meet our instructional goals, [where] all treatments are equally valuable for learning but . . . usually differ in their cost and convenience.[31]

If M-Learning falls into this category, it would indicate that the paradigm was no more or less effective than FTF. Alternately, are there enough significant, distinct, advantageous and practical differences between M-Learning and FTF that would prove the former to be more desirable than the latter?

30. Russell, *The No Significant Difference Phenomenon*, ix.

31. Ibid., x.

Chapter 2 Literature Review

2.1 Introduction

Educators and administrators of conventional, 'brick and mortar' post-secondary education institutions face a daunting question: As society becomes increasingly mobile, how can institutions best educate, support, retain, and otherwise accommodate students equipped with cutting-edge, small information appliances that facilitate and/or augment learning beyond the conventional classroom?

In 1999, Chien discusses what modern technologies would afford us the opportunity to do:

> . . . dramatically advance the means to collect, store, and organize information in digital forms of all kinds - data, text, images, motion video, sound, and integrated media - and make it available and sharable for searching, retrieval, and processing via high-performance communication networks in ways that transcend distance and time.[32]

The functionality Chien describes is now a reality. The networks to which he refers are also commonplace. In addition, inexpensive multimedia information appliances capable of capturing and playing the digital content he envisioned are prolific.

There are few barriers to the distribution of digitized course content in an M-Learning environment; content hosting and network infrastructures exist, and media

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32. Y.T. Chien, "Digital Libraries, Knowledge Networks, and Human-centered Information Systems," (paper presented at the International Symposium on Research, Development & Practice in Digital Libraries, Tsukaba Science City, Japan, November 18-21, 1997), under "The Digital Library Research Initiative," http://www.dl.slis.tsukuba.ac.jp/ISDL97/proceedings/ytchien/ytchien.html (accessed June 13, 2007).

devices capable of downloading content are omnipresent. It remains for organizations and administrators entrenched in classical andragogical methodologies to push the envelope; to embrace cybergogical principles[33] and employ modern multimedia instructional design methodologies. Organizations and administrators should overcome what have simply become artificial and superficial hurdles that stand in the way of providing a growing constituency of adult learners with access to education.

Demand for non-traditional course content has increased steadily as a modern, mobile workforce continues to extend beyond the conventional classroom. The physical distance of students from the conventional campus has increased proportionately with the global dissemination of information:

> Particularly in the last decade, the Internet has emerged as a simple means for the instantaneous global dissemination of information. The Internet is especially well suited to providing access to data and applications information on innovative materials and products as soon as the data are available.[34]

Demand for M-Learning has also increased as a function of the requirement that the workforce be more educated than that of yesteryear; since 1966 we have been ". . . living through a period of profound change and transformation of the shape of society

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33. ". . . the continued and growing need for new learning opportunities, linked with newer information systems and communication technologies [that] has pushed online learning into the center of the discussion of educational practice. . . . a need to establish a framework for generating meaningful and engaging learning experiences for distance students with diverse cultural and linguistic backgrounds . . . a descriptive label for the strategies for creating engaged learning online." – David Hyung and Myint Swe Khine, eds., *Engaged Learning with Emerging Technologies* (Dordrecht, Netherlands: Springer Netherlands, 2006), 225-253.

34. Richard W. Bukowski and Richard D. Peacock, "Global Dissemination of Performance Data and Information", (paper presented at the International Council for Innovation and Research in Building and Construction, Wellington, New Zealand, April 2-6, 2001), http://www.fire.nist.gov/bfrlpubs/fire01/PDF/f01107.pdf (accessed June 15, 2007).

and its economic base . . . the nature of production, trade, employment and work in the coming decades will be very different from what it is today."[35]

There exists great demand for workers who possess a post-secondary degree preparing them for productive participation in the knowledge economy; "[a]s our society is entering a knowledge-based, Internet/Web-driven economy, college education becomes a necessity for any individual who wants to be competitive and successful, regardless of his or her age, gender, and race."[36]

In July 2006 Don Francis, president of The Association of Independent Colleges and Universities of Pennsylvania states:

> Regardless of time and place, providing access to education for those wishing to be successful in this economy should become the cornerstone of educational institutions' attempts to prepare students for success . . . this is what we all hope that education will do . . . what the data are showing is that education is leveling the playing field for people from different socio-economic categories.[37]

35. Thomas B. Riley, "An Overview of the Knowledge Economy," *eGov Monitor*, August 2003, http://www.egovmonitor.com/features/riley07.html (accessed November 7, 2007); Walter W. Powell and Kaisa Snellman, "The Knowledge Economy," *Annual Review of Psychology* 30 (2004): 199-220, http://arjournals.annualreviews.org/doi/pdf/10.1146/annurev.soc.29.010202.100037?cookieSet=1 (accessed July 21, 2007); "Shaping our Future: A Strategy for Enterprise in Ireland in the 21st Century," *Forfás* May 1, 1996, under "The Need for a Long-Term Framework for Enterprise Development," http://www.forfas.ie/publications/archive/sof/chap1.htm (accessed August 3, 2007).

36. *Crusader for Social Causes*, vol. 13 of *The Works of Irving Fisher*, ed. William J. Barber, (London: Pickering & Chatto, 1997), 13, quoted in Nitin Upadhyay, "M-Learning – A New Paradigm in Education," *International Journal of Instructional Technology and Distance Learning*, 3, no. 2 (February 2006), http://itdl.org/Journal/Feb_06/article04.htm (accessed February 23, 2007); J. F. Gubrium and J. A. Holstein, *The New Language of Qualitative Method* (New York: Oxford University Press, 1997), quoted in Nitin Upadhyay, "M-Learning – A New Paradigm in Education," *International Journal of Instructional Technology and Distance Learning*, 3, no. 2 (February 2006), http://itdl.org/Journal/Feb_06/article04.htm (accessed February 23, 2007).

37. University Business, "Education as Equalizer," http://www.universitybusiness.com/ViewArticle.aspx?articleid=217 (accessed November 7, 2007).

Higher education institutions that solely present courses in conventional, instructor-led classrooms face a mounting threat from D-Learning. "Defined in its most basic form, distance learning occurs when the student and the instructor are logistically separated."[38] D-Learning precludes the need for students to be in conventional, brick and mortar classrooms at a pre-established time and place – something which the growing population of mobile learners wishes to do.

Against this background, M-Learning has been nurtured through: 1) advanced D-Learning implementation strategies derived from Pitman[39], 2) extensions of proven instructional design methodologies pioneered by researchers such as Gagné and Bloom, and 3) the proliferation of small information appliances. This nurturing has led to a morphing of D-Learning into E-Learning; the latter of which gave birth to M-Learning.

D-Learning has matured from a tethered delivery strategy offered through mail into a delivery strategy mediated by electronic devices (E-Learning), and now a robust mobile learning strategy delivered wirelessly to students in a virtual, mobile classroom.

38. Russell K. Baker, "A Framework for Design and Evaluation of Internet-Based Distance Learning Courses: Phase One – Framework Justification, Design and Evaluation," http://www.westga.edu/~distance/ojdla/summer62/baker62.html (accessed November 14, 2007).

39. "Distance education can trace its roots to 1840 when Sir Isaac Pitman, the English inventor of shorthand, came up with an idea for delivering instruction to a potentially limitless audience: correspondence courses by mail." Diane Matthews, "The Origins of Distance Education and its use in the United States," *T•H•E Journal*, September 1999, http://www.thejournal.com/articles/14278 (accessed July 23, 2008). For a useful history of Sir Isaac Pitman, see *The Concise Oxford Companion to the English Language*, (Oxford: Oxford University Press, 1992), s.v., "Pitman, (Sir) Isaac."

Technology has afforded these students the opportunity to interact with classmates and instructors anytime, and anywhere.[40]

With the requisite architecture in place – infrastructure, tools, and teaching strategies, etc. – it seems almost inexcusable to prohibit learners from acquiring an education simply because of time, travel, and proximity constraints; a simultaneously abhorrent and preventable situation. Those individuals who opt, or are forced, to be away from the classroom should be supported and provided with an educational experience in a fashion similar to their FTF counterparts.

Supporting M-Learning students comprises providing access to anytime, anywhere learning via handheld devices and wireless networks, etc., and making the resulting content available to learners in non-traditional locations. As D-Learning transformed into E-Learning which subsequently yielded to M-Learning, we have witnessed yesterday's D-Learning strategies evolved into today's M-Learning implementations.

University educators may want to target the growing array of available electronic resources in order to provide a rich technology-based learning environment that fosters flexibility, connectivity, and collaboration while engaging students by making learning

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40. Sir John Daniel, "International Perspectives on Open Learning and Distance Education," (lecture, National Policy Consultative Forum on Open Learning and Distance Education, Kenya, Africa, September 13-15, 2004), under "Printing and posting: distance learning for individuals, " http://www.unisa.ac.za/contents/management /ProVC/docs/Sir_John_Daniel-Conference_paper.pdf (accessed July 15, 2007); Robert M. Gagné, Leslie J. Briggs, and Walter W. Wager, *Principles of Instructional Design* (New York: Holt, Rinehart, and Winston, 1988); Benjamin S. Bloom, ed., Taxonomy of Educational Objectives: The Classification of Educational Goals, by a Committee of College and University Examiners. Handbook 1: Cognitive Domain (New York: Longmans, 1956); Cyber Media Creations, "eLearning Glossary and Technical Terms," under "V," http://www.cybermediacreations.com/eLearning_Glossary_V.pdf (accessed August 21, 2007).

fun.[41] Moreover, these educators should look to provide students who have access to mobile technology such as laptop computers and hand-held devices an opportunity to engage in an interactive, mobile environment.

Technology evolution has provided modern handheld devices, and non-traditional small-form computers such as monitors embedded in the back of airline headrests, etc., which have extended the scope of D-Learning far beyond its roots:

> Those who complain that education is slow to adopt new technologies might note that correspondence education began almost immediately after Britain introduced a universal postal system, the Penny Post . . . [in the 1870's] . . . courses in shorthand [were offered] almost immediately and correspondence education was born. It began as a private commercial venture and correspondence education has always retained a strong commercial component, even though governments and public universities also began offering corresponding education in the 20th century. [42]

It is improbable that Pitman imagined his asynchronous course to be the foundation of E-Learning. In 1922, Thomas Alva Edison was seemingly omniscient when he predicted the future of electronic learning delivery strategies when he stated that ". . . movies [will] replace textbooks and perhaps teachers in the classroom."[43]

The promise of new course content delivery strategies far surpasses the future envisioned by Edison. As regions of the world with broadband access continue to proliferate, the boundaries of the classroom of the future expand. Learning objects,

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41. International Journal of Networking and Virtual Organizations, "Call for Papers – Special Edition: On 'Toward Virtual Universities'," INDERSCIENCE Publishers, http://www.inderscience.com/browse/callpaper.php?callID=705 (accessed July 12, 2007).

42. Pitman Training, under "About Us," http://www.pitman-training.com/about_us.php (accessed November 23, 2007); Sir John Daniel, "International Perspectives".

43. K. C. Mera, "E-Learning: The Acorn Begins to Grow," *Domain-b.com*, December 2002, under "Mumbai," http://www.domain-b.com/infotech/itfeature/20021203_e-learning.html (accessed August 1, 2008).

wireless networks, and small information appliances are poised to augment, and quite possibly replace, textbooks and teachers.

With a network in place, courses can be delivered across relatively small bandwidths. Synchronous access to content is not required because the ability to download content is enough. Once downloaded, students only need a playback device to access objects and engage in M-Learning activities.

2.2 Distinguishing D-, E-, and M-Learning

Wireless networks and small information appliances afford the creation of an architecture where homogenous objects can be used across heterogeneous devices. The process whereby these objects are played over wireless networks by small information appliances has given rise to M-Learning; a subset of D-Learning.

D-Learning is synonymous with the delivery of courseware from afar. The learning paradigm passed this characteristic to M-Learning which augmented the delivery methodology with mobile course access. In addition, M-Learning demonstrates another important characteristic of D-Learning; taking advantage of new methods for learning distribution shortly after they are introduced; to wit, Pitman and the Penny Post.[44]

Shortly after their introduction, a host of technologies including radio programming, local television, e.g. the U.S. Public Broadcasting System, and eventually telephone- and video-based courses were considered delivery media for D-Learning. In addition, videoconferencing, FAX, and satellite, etc., were utilized shortly after their

44. For accounts of additional milestones in M-Learning history, see Appendix 1; Sir John Daniel, "International Perspectives," under "Printing and Posting: Distance Learning for Individuals".

introduction as learning object delivery media, e.g. television was born circa 1923[45]. Just three years later:

> . . . the educationalist and historian J. C. Stobart wrote a memo, while working for the infant BBC [British Broadcasting System], advocated a 'wireless university'. By the early sixties many different proposals were being mooted. R. C. G. Williams of the Institution of Electrical Engineers argued for a 'teleuniversity', which would combine broadcast lectures with correspondence texts and visits to conventional universities - a genuinely 'multi-media' concept.[46]

As this concept became a reality, Iain Macleod, then Prime Minister of Great Britain, described it as ". . . blithering nonsense." One year later the first student applications for what would become the 'Open University' (OU) were accepted.[47]

This reliance of D-Learning on electronic devices came to be known as E-Learning. In turn, E-Learning gave way to M-Learning. The latter scenario occurred when a host of technology resources and learning needs aligned; network infrastructures and small information appliances matured, learners became increasingly mobile, and the technology to support them began to proliferate.

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45. Sharon Jeffcoat Bartley and Jennifer H. Golek, "Evaluating the Cost Effectiveness of Online and Face-to-Face Instruction," *Educational Technology and Society*, 7, no. 4 (2004): 167-175. http://www.ifets.info/journals/7_4/16.pdf (accessed November 12, 2007); Eva Kaplan-Leiserson, "Learning Circuits: ASTD's Source for E-Learning, American Society for Training and Development," under "Distance Education," http://www.learningcircuits.org/ASTD/Templates/LC/LC_OneBox.aspx?NRMODE=Published&NRORIGINALURL=%2fglossary&NRNODEGUID=%7bA1A2C751-7E81-4620-A0A3-52F3A90148EB%7d&NRCACHEHINT=NoModifyGuest#D (accessed August 15, 2007); Physlink.com, "Who is the Inventor of Television?" http://www.physlink.com/Education/AskExperts/ae408.cfm (accessed October 23, 2007).

46. The Open University, "About the OU: History of the OU," under "The Early Years: The Idea Starts with the BBC," http://www.open.ac.uk/about/ou/p3.shtml (accessed November 7, 2007).

47. The Open University, "About the OU," under "Is the Open University a Real University?"; Ibid., under "The First Student Applications: 1970".

M-Learning had shattered the requirements for students to be seated for lengthy periods at a given time and place. It enabled students to take courses at their convenience: 1) at a location they desired, 2) at a time they chose, 3) untethered, and 4) facilitated by information appliances that continued to fall in price.

D-, E-, and M-Learning all provide communication between instructor and student. This characteristic often causes confusion and consequently leads to the methods being interchangeably used. To clarify, D-Learning is defined as learning at a distance. E- and M-Learning, as subsets of D-Learning, also provide for learning at a distance. Thus, although they have their own peculiarities based on learning object design and delivery medium, they represent a means to the same D-Learning end.

- D-Learning:

  > . . . [a] General term used to cover the broad range of teaching and learning events in which the student is separated (at a distance) from the instructor, or other fellow learners.[48]
  >
  > The acquisition of knowledge and skills through mediated information and instruction, encompassing all technologies and other forms of learning at a distance.[49]

- E-Learning (D-Learning utilizing electronic devices):

  > . . . learning from any device dependent upon the actions of electronics, such as television, computers, microcomputers, videodiscs, video games,

48. Glenn Hoyle, "What is Distance Education and Distance Learning?" http://www.hoyle.com/distance/define.htm (accessed September 17, 2007).

49. The United States Distance Learning Association, quoted in, "Advising Distance Learners," National Academic Advising Association, under "Defining Distance Learning," http://www.nacada.ksu.edu/clearinghouse/AdvisingIssues/adv_distance.htm (accessed November 6, 2007).

> cable, radio interactive cable, videotexts, teletext, and all the other devices in the process of being invented that are electronic in nature. [50]

- M-Learning (. . . an approach to E-Learning that utilizes mobile devices):[51]

> [the] . . . intersection of mobile computing (the application of small, portable, and wireless computing and communication devices) and e-learning (learning facilitated and supported through the use of information and communications technology).[52]

Agnes Kulkulska-Hulme of the OU Institute of Educational Technology, U.K., and John Traxler of the [sic] Centre for Learning and Teaching at the University of Wolverhampton, distinguish M-Learning from D-Learning and E-Learning via the *vision*, rather than *definition* of the former: ". . . a new concept [in which learners] should be able to engage in educational activities without the constraints of having to do so in a tightly delimited physical location."[53]

Kulkulska-Hulme also addresses the generalizability of out-of-classroom learning by focusing on what M-Learning enables:

> . . . the possibilities opened up by portable, lightweight devices that are sometimes small enough to fit in a pocket or in the palm of one's hand. Typical examples are mobile phones . . . smartphones, palmtops, and handheld computers; Tablet PCs, laptop computers and personal media players can also fall within its scope.[54]

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50. *The Future of Electronic Learning* ed. Mary Alice White (Hillsdale, NJ: Lawrence Erlbaum Associates, 1983), 51.

51. David Parsons and Hokyoung Ryu, "A Framework for Assessing the Quality of Mobile Learning," under "1 Introduction," http://www.massey.ac.nz/~hryu/M-Learning.pdf (accessed September 17, 2007).

52. Joseph Rene Corbeil, and Maria Elena Valdes-Corbeil, "Are You Ready for Mobile Learning?" *Educause Quarterly* 11 no. 2 (2007): 51, http://connect.educause.edu/library/abstract/AreYouReadyforMobile/40029 (accessed September 19, 2007).

53. Agnes Kukuklska-Hume and John Traxler, *Mobile Learning: A Handbook for Educators and Trainers* (NY: Taylor & Francis, 2007), 1.

54. Ibid., 1.

Further differentiating M- and E-Learning from D-Learning is the functionality of M- and D-Learning which affords the use of both electronically asynchronous (non-simultaneous interaction) and synchronous (text messaging, virtual chat rooms, etc. that provide the opportunity for simultaneous communications) environments. This is in contrast to the one-way dialog typically associated with D-Learning (mail, television, fax, etc.).

To distinguish E- from M-Learning Upadhyay designed a model where the delivery methods were differentiated through a continuum consisting of functionality and mobility (see figure 2.1).

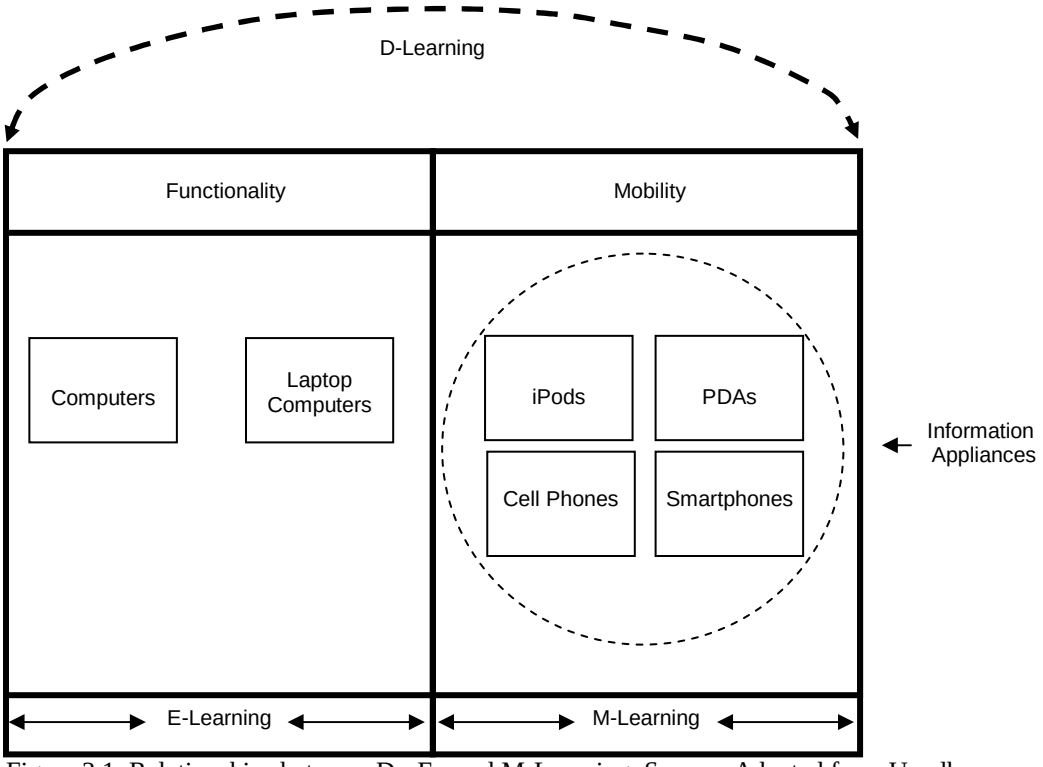

Figure 2.1. Relationships between D-, E-, and M-Learning. *Source:* Adapted from Upadhyay, "M-Learning – A New Paradigm in Education," under "Advantages of Mobile Learning," http://www.itdl.org/Journal/Feb_06/article04.htm (accessed September 21, 2007).

In 2005, Keegan visually differentiated E- and M-Learning, with two models, 'Today' and 'Tomorrow', respectively (see figure 2.2).

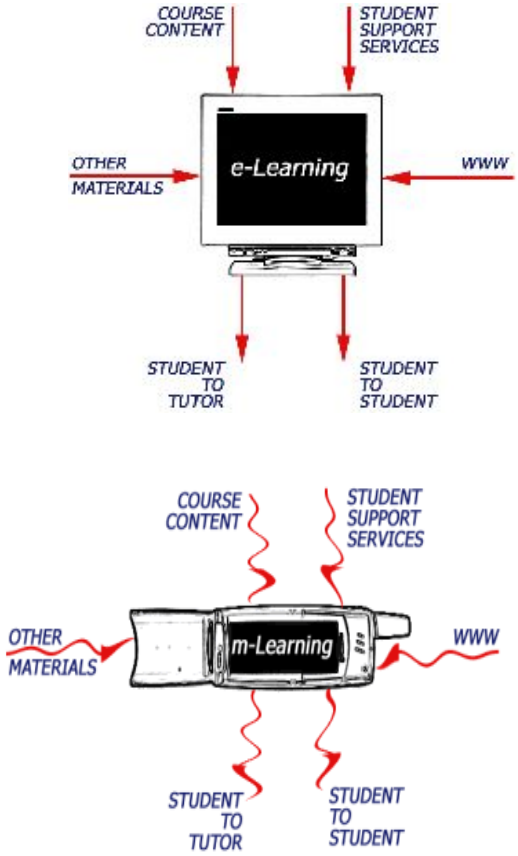

Figure 2.2. *Above*, The Wireless Virtual Learning Environment of 'Today' (2005). *Source* Desmond Keegan, "M-Learning – How far has it Come?" (lecture presented at the Mobile Learning: The Next Generation of Learning conference, Dun Laoghaire, Co. Dublin, Ireland, September 9, 2005), http://learning.ericsson.net/mlearning2/files/conference/dkeegan.pdf (accessed September 21, 2007); *below,* The Wireless Virtual Learning Environment of 'Tomorrow'. *Source:* Keegan, "M-Learning".

Both models show similar functionality, i.e. course content, student support services, etc., but each demonstrates these features of the wireless learning environment being executed differently. In the case of E-Learning, a tethered approach is utilized. In the case of M-Learning, the same processes are performed in an exclusively wireless environment.

Keegan's 'Tomorrow' model delivers course content via the cell phone – an untethered, wireless small information appliance. In the two years that transpired from Upadhyay's model to Keegan's, M-Learning had become a reality; Upadhyay proclaimed that, ". . . M-Learning has now emerged as a new wave of development."[55] A shift was made from that of an M-Learning vision, to an M-Learning reality.

Laouris and Etokleous[56] further differentiate E-Learning and M-Learning by the use of terminology that came about as a result of the introduction of the latter (see table 2.1).

Table 2.1. Terminology Comparisons between E-Learning and M-Learning

E-Learning	M-Learning
Computer	Mobile
Bandwidth	GPRS, G3, Bluetooth
Multimedia	Objects
Interactive	Spontaneous
Hyperlinked	Connected
Collaborative	Networked
Media-rich	Lightweight
Distance learning	Situated learning
More formal	Informal
Simulated situation	Realistic situation
Hyperlearning	Constructivism, Situationism, Collaborative

Source: Laouris and Etokleous, "We Need an Educationally Relevant Definition of Mobile Learning."

The maturation of M-Learning as a viable alternative to D-Learning and E-Learning has been enabled by many factors. Keegan identified one as the introduction of

55. Upadhyay, "M-Learning," under "Abstract".

56. Yiannis Laouris and Niklei Etokleous, "We Need an Educationally Relevant Definition of Mobile Learning," (paper presented at the 2005 4th World Conference on mLearning, Cape Town, South Africa, October 2005), http://www.mlearn.org.za/CD/papers/Laouris%20&%20Eteokleous.pdf (accessed November 19, 2007).

the cell phone – Upadhyay also identified the cell phone as an enabler and further refined Keegan's model with the introduction of additional small information appliances.

In the M-Learning environment, new software and hardware designed to enable and enhance communications between man, machine, and combinations therein were quickly adopted as enablers. As advances were steadily made in the small information appliance industry they were soon incorporated into the M-Learning paradigm. Sharples referred to these technologies as the, ". . . software, hardware, communications and interface designs of a handheld learning resource, or HandLeR," [57] which enable 'handheld learning'.

2.3 Face to Face Learning

The roots of FTF learning can be traced to philosophers in ancient Greece, Egypt, China, and India as far back as the teachings of Confucius (551 – 479 B.C.).[58]

More recently, during the Middle Ages in Europe (5^{th} to 15^{th} centuries), the Roman Catholic Church assumed responsibility for learning – removing the practice from private citizens and loosely-bound, semi-formal institutional relationships. Under this

57. Mike Sharples, "The Design of Personal Mobile Technologies for Lifelong Learning," *Computers and Education*, 34 (2000): 177, http://www.eee.bham.ac.uk/sharplem/Papers/handler%20comped.pdf (accessed November 8, 2007).

58. Think Quest, "History of Learning," under "The Spring and Autumn Period," http://library.thinkquest.org/C005704/content_teaching_history.php3 (accessed November 8, 2007).

scenario, learning was allocated to monasteries and unique, formal 'Learning Centers'. Eventually, these centers turned into what are now recognized as universities.[59]

The 17th and 18th centuries saw a shift in focus from education generalizable across all ages to the unique art and science of educating children, commonly referred to as 'pedagogy':

> . . . the Ancient Greek word paidagogas, which is derived from the word for the slave (pais) who leads (agogas) the children (also, pais) to school, and then comes to mean the mode of instruction itself.[60]

In 1950, attention was drawn to the art and science of learning specifically designed to address the needs of the adult learner. It was not until 1970, however, that a term referring to this process was coined. Attributed to Malcolm Knowles, it was labeled 'andragogy' (adult learning).[61] Knowles' andragogical theories have been described as ". . . an attempt to develop a theory for all adult learners . . . [because] adults tend to be self-directed and expect to take responsibility for decisions . . . education programs need to accommodate these fundamental aspects."[62]

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59. Interactives, "Middle Ages: What was it Really Like to Live in the Middle Ages," www.learner.org/exhibits/middleages/ accessed (November 9, 2007); Think Quest, "History," under "History of Teaching".

60. Riana St. Classis, "Learning the Science of Pedagogy," *21st Century Science and Technology Magazine*, Summer 2003, under "Becoming Leaders," http://www.21stcenturysciencetech.com/articles/Summer03/learning.html (accessed November 8, 2007).

61. The Ontario Institute for Studies in Education of the University of Toronto, Department of Adult Education, Community Development and Counseling Psychology, "History of Education: Selected Moments of the 20th Century," http://fcis.oise.utoronto.ca/~daniel_sc/assignment1/1970knowles.html (accessed November 12, 2007).

62. Rebecca H. Rutherfoord, "Andragogy in the Information Age: Educating the Adult Learner," Southern Polytechnic State University, under "Abstract," http://delivery.acm.org/10.1145/1030000/1029615/p282-rutherfoord.pdf?key1=1029615&key2=2813626911&coll=GUIDE&dl=GUIDE&CFID=7996615&CFTOKEN=61772395 (accessed November 28, 2007).

This environment is especially well suited to M-Learning; digitized course content can be downloaded and consumed at an adult learners' leisure (self-direction). Further, under this learning strategy students are provided with the opportunity to participate based upon their penchant. Subsequent evaluations, based upon quality of work, can be aligned with their level of participation (taking responsibility for decisions).

Andragogy described those teaching strategies employed in the instruction of adult learners. Says Donald Clark, "[i]n pedagogy the concern is with transmitting the content, while in andragogy, the concern is with facilitating the acquisition of the content."[63] This study, which focused on adult learners in post-secondary education institutions, employed andragogical techniques.

Between 1945 and 1965 interest intensified in the study of European andragogical principles. Later coined the 'cognitive revolution'[64], the period saw scholars and scientists such as Jean Piaget and B.F. Skinner conduct andragogical studies. The researchers began to move away from the study of knowledge acquisition and behaviorism of previous periods to the study of information and the way it is processed.[65]

This revolution was caused in part by the introduction of the computer, which Thinkquest referred to as ". . . [a] metaphor for the human mind." The mind came to be

63. Donald Clark, "Andragogy," http://www.nwlink.com/~donclark/hrd/history/history.html, (accessed November 9, 2007).

64. David Martel Johnson and Christina E. Erneling, eds., *The Future of the Cognitive Revolution* (New York: Oxford University Press, 1997).

65. Richard J. Mueller and Christine L. Mueller, *The Cognitive Revolution and the Computer. Version 2* (DeKalb IL: Self Published, 1995).

considered in terms of how information is inputted, stored, and retrieved" (see figure 2.3).

Figure 2.3. The Cognitive Revolution: The Metaphor of the Human Mind. *Source:* The Learning Curve, "History of Teaching," Thinkquest, http://library.thinkquest.org/C005704/content_hl_cr.php3 (accessed December 18, 2007).

The model maps closely to the information processing model, also know as the 'Information Systems (IS) model' which comprises data input, storage, processing and output. According to Matlin, "[t]he information processing model emerged from many sources, including communication and computer science. It has proven to be a useful and productive model of the human learning process" (see figure 2.4).[66]

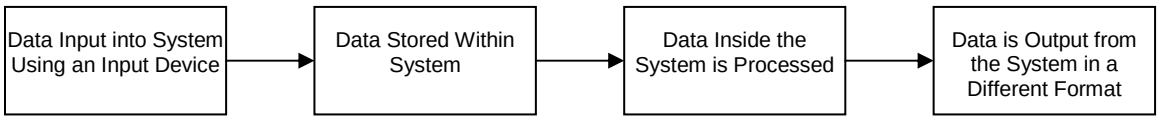

Figure 2.4. The Information Systems (IS) Model. *Source:* Adapted from C. Johnson, "2360 Analysis Lesson 9: Data Input, Storage, Processing and Output," Sidney Stringer Community Technical College, Coventry, England, http://86.20.61.25/resources/ks4/Unit04/2004/Analysis/2360Lesson9dataInputStorageProcessingOutputStudentVersion.ppt#261,1,2360 Analysis Lesson 9: Data Input, Storage, Processing and Output (accessed November 19, 2007).

> The cognitive metaphor of mind is often referred to as the computational analogy . . . the operations of the human mind are taken to be analogous to those of a computer. The brain is compared to the hardware and mental operations are compared to the software or operating programs used in the computer. On this view humans are taken to be one example of an "IP system" and the study of the mind is focused on the "mental" level of description through *models* and simulations. Models of IP range according to levels of concreteness, from mechanical models and flow charts to less concrete pictorial, symbolic, and verbal models. The predominant model is that of action as a result of IP, similar to that of a computer. IP is a *functional* or operational view of mind, that is, it is concerned with *how* the mind functions as a system to access and process information and

66. M. W. Matlin, *Cognition*, 2nd ed. (NY: Holt, Rinehart & Winston, 1983).

> ultimately, to produce knowledge. *IP is paradigmatic in the fields of cognitive psychology and cognitive science, that is, it is assumed to be the best operational view of mind upon which to base learning-theory research* [emphasis added].[67]

After the merger of learning and IS models it took little time for educators and systems developers to capitalize on the marriage and introduce IS-based education models; D-Learning, E-Learning, and M-Learning alike, e.g. the 1969 introduction of the OU's televised course network. As small information appliances and network infrastructures emerged, e.g., the Internet (circa 1970),[68] cell phones (1973), World Wide Web (1989),[69] and PDAs (1993)[70], etc., IS-based learning projects had been provided a platform upon which to build.

FTF Learning as a model of interaction between teacher and student has demonstrated success based on two objective metrics: 1) longevity and 2) acceptance. The FTF learning model has been in use around the globe for centuries. As a widely accepted model, exemplars included "classrooms" in modest dwellings situated in small villages in some of the poorest regions of the world and formal institutions in developed nations.

Over time, FTF has taken on many forms; thousands of years ago priests, prophets, and religious figures acted as instructors, often with small student/teacher

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67. Shelby Sheppard, "Education and the Cognitive Revolution: Something to "Think" About," *Philosophy of Education* (1997).

68. Tim Berners-Lee, "Commemorative Lecture: The World Wide Web – Past, Present, and Future," http://www.w3.org/2002/04/Japan/Lecture.html (accessed November 12, 2007).

69. Tim Berners-Lee, "Homepage," http://www.w3.org/People/Berners-Lee/ (accessed November 12, 2007).

70. For an account of this and other significant milestones in M-Learning history, see Appendix 1.

ratios, to include ‘class’ sizes as small as one. Today, these instructors still fill the teaching role, as do faculty in formal classrooms comprising both small and large student/teacher ratios. In addition, FTF in the form of ‘training’ is conducted on job sites, at organizations, and in homes, etc., by those more knowledgeable than others in a given subject matter, e.g. one worker demonstrating the functionality of a software application to a colleague.

FTF is the foundation of other learning models to include D-, E-, and M-Learning. As a several-thousand-year-old exemplar of learning delivery, FTF significantly predates the earliest documented D-Learning efforts.

Figure 2.5 shows the layering of D-, E-, and M-Learning models upon the FTF foundation.

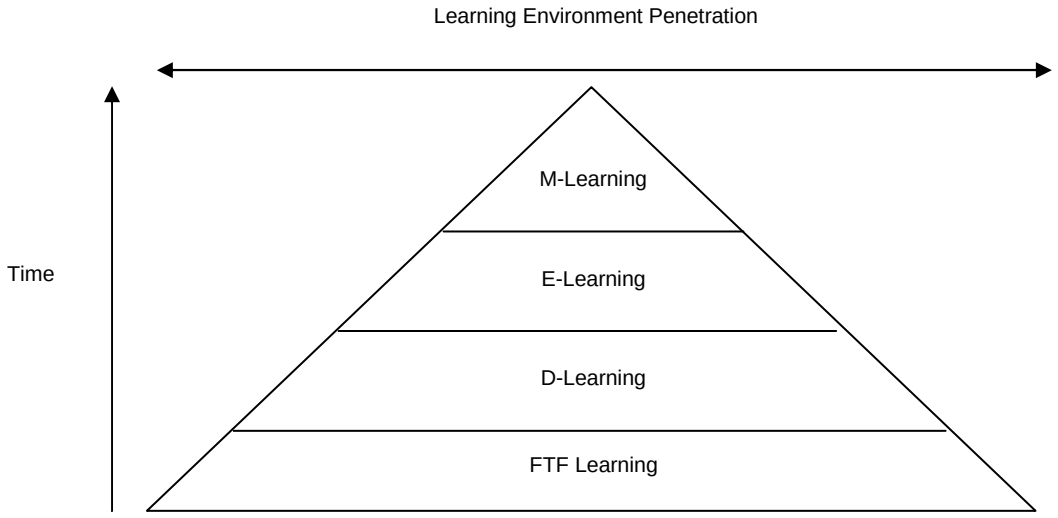

Figure 2.5. A Hierarchy of Learning Methodologies. *Source:* Investigator.

Figure 2.5 depicts D-Learning as the foundation for E-Learning, and E-Learning as the foundation for M-Learning. This is consistent with Upadhyay’s model. Content

delivery differentiates the four delivery methodologies . . . most notably electronic versus non-electronic. Learning content is delivered by each paradigm but each strategy's transmission channel is significantly different.

Since the introduction of FTF, instructional design methodologies have been refined and formalized to attend to the evolving needs of a growing audience of learners – children, adults (both traditional and non-traditional), and those who are mobile. Throughout this time, and regardless of audience and transmission channel, the basic tenet of both pedagogical and andragogical instructional methods has remained the same; ". . . learning is a means to transfer knowledge between teacher and student."[71]

2.4 M-Learning

> The next big killer application of the Internet will be education . . . it will make email look like a rounding error.
>
> – John Chambers, CEO Cisco Systems
> COMDEX Conference 1999

M-Learning technologies may continue to broaden the boundaries of the conventional classroom, making it possible for the learning strategy to become as prolific and, possibly, as effective as FTF learning. Many of the ambiguities surrounding D-Learning, E-Learning, and M-Learning were resolved by the research of Kulkulska-Hulme, et al., Upadhyay, and Keegan. Debate, however, continues to surround the placement of the fledgling M-Learning delivery medium along the 'Hype Cycle' continuum as compared to the more mature E-Learning strategy (see figure 2.6).

71. The Learning Curve, "History of Learning," under "The Spring and Autumn Period".

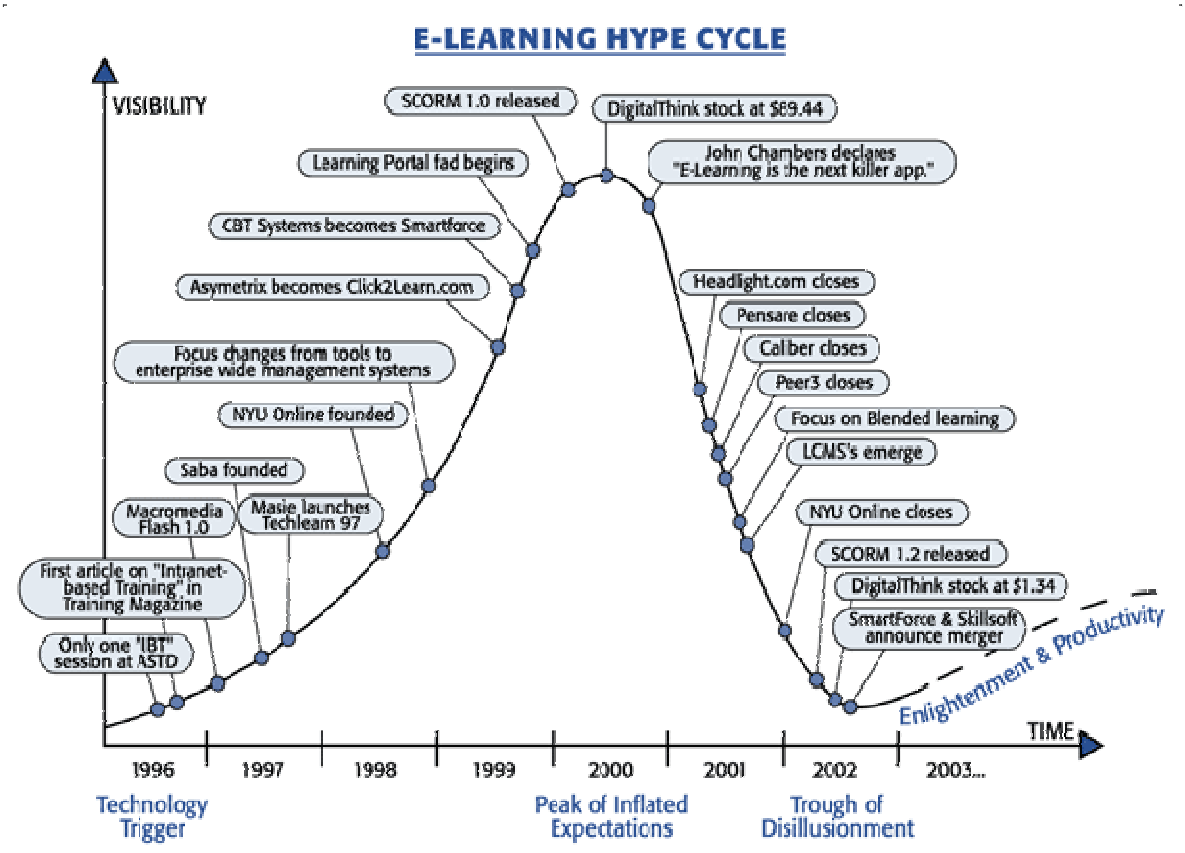

Figure 2.6. E-Learning Hype Cycle. *Source:* Kevin Kruse, "The State of e-Learning: Looking at History with the Technology Hype Cycle," e-learningGURU.com, under "The Triggers," http://www.e-learningguru.com/articles/hype1_1.htm (accessed September 17, 2007).

Kruse estimated a 1996 (X axis) technology trigger for E-Learning, thus providing it mainstream visibility (Y axis). For M-Learning, the 'Technology Trigger' was the 1970 introduction of Dynabook; "[a] . . . proprietary pen-tablet mobile learning computer,"

Dynabook was credited as being the first proposed hardware device designed specifically for M-Learning.[72]

After physically connecting to a host computer, Dynabook provided the ability for data (reference materials, poems, letters, records, etc.) to be downloaded for anywhere, anytime viewing. Kay proposed that Dynabook would weigh less than four pounds with dimensions of approximately 12" x 9" x 3/4" (L x W x H) – similar to today's tablet and laptop computers.

Kay's extraordinarily prescient paper predated by some 10 years the first fully functional, commercially available laptop created, arguably, by Manny Fernandez.[73] Kay described his Dynabook design: [74]

> Imagine having your own self contained knowledge manipulator in a portable package the size and the shape of an ordinary notebook. Suppose it had enough power to out race your senses of sight and hearing, enough capacity to store for later retrieval thousands of page equivalents of reference materials, poems, letters, recipes, records, drawings, animations, musical scores, waveforms, dynamic simulations and anything else you would like to remember and change.

72. Alan Kay and Adele Goldberg, "Personal Dynamic Media," *IEEE Computer*, 10, no. 3 (March 1977): 31.

73. PDA Reviews, "Mobile Learning," http://www.pdas-news.com/Mobile-learning.php (accessed September 12, 2007); Alan C. Kay, "A Personal Computer for Children of All Ages," (unpublished document – Xerox Palo Alto Research Center) http://www.mprove.de/diplom/gui/Kay72a.pdf (accessed September 19, 2007); About.com: Inventors, "History of Laptop Computers – History," under "Gavilan Computer as the First Laptop?" http://inventors.about.com/library/inventors/bllaptop.htm (accessed September 19, 2007).

74. Kay and Goldberg, "Personal Dynamic Media," 31.

In 1996 M-Learning became ". . . state of the art for the use of technology in education."[75] Shortly thereafter, in 2001, there were at least 30 mobile learning initiatives underway.[76] These initiatives not only increased M-Learning's visibility, but also saw it maintain continued hype cycle momentum. E-Learning took 4 years to move along the hype cycle continuum from technology trigger to decreased visibility. In contrast, M-Learning continues to gain visibility almost 40 years after its birth – an exponential difference that caused Geoff Stead to comment in 2005 that ". . . interest in M-Learning has intensified over the past five years"[77] (see figure 2.7).

75. Paul Landers, "The Future of Learning," under "Chapter 3. From eLearning to mLearning – The Arrival of mLearning," http://learning.ericsson.net/mlearning2/project_one/thebook/chapter3.html (accessed June 5, 2007).

76. Ibid., http://learning.ericsson.net/mlearning2/project_one/thebook/chapter4.html, (accessed November 23, 2007).

77. Geoff Stead, "Moving Mobile into the Mainstream," (paper presented at MLearn 2005, Cape Town, South Africa, October 25-28, 2005), under "Abstract", http://www.mlearn.org.za/CD/papers/Stead.pdf (accessed September 3, 2007).

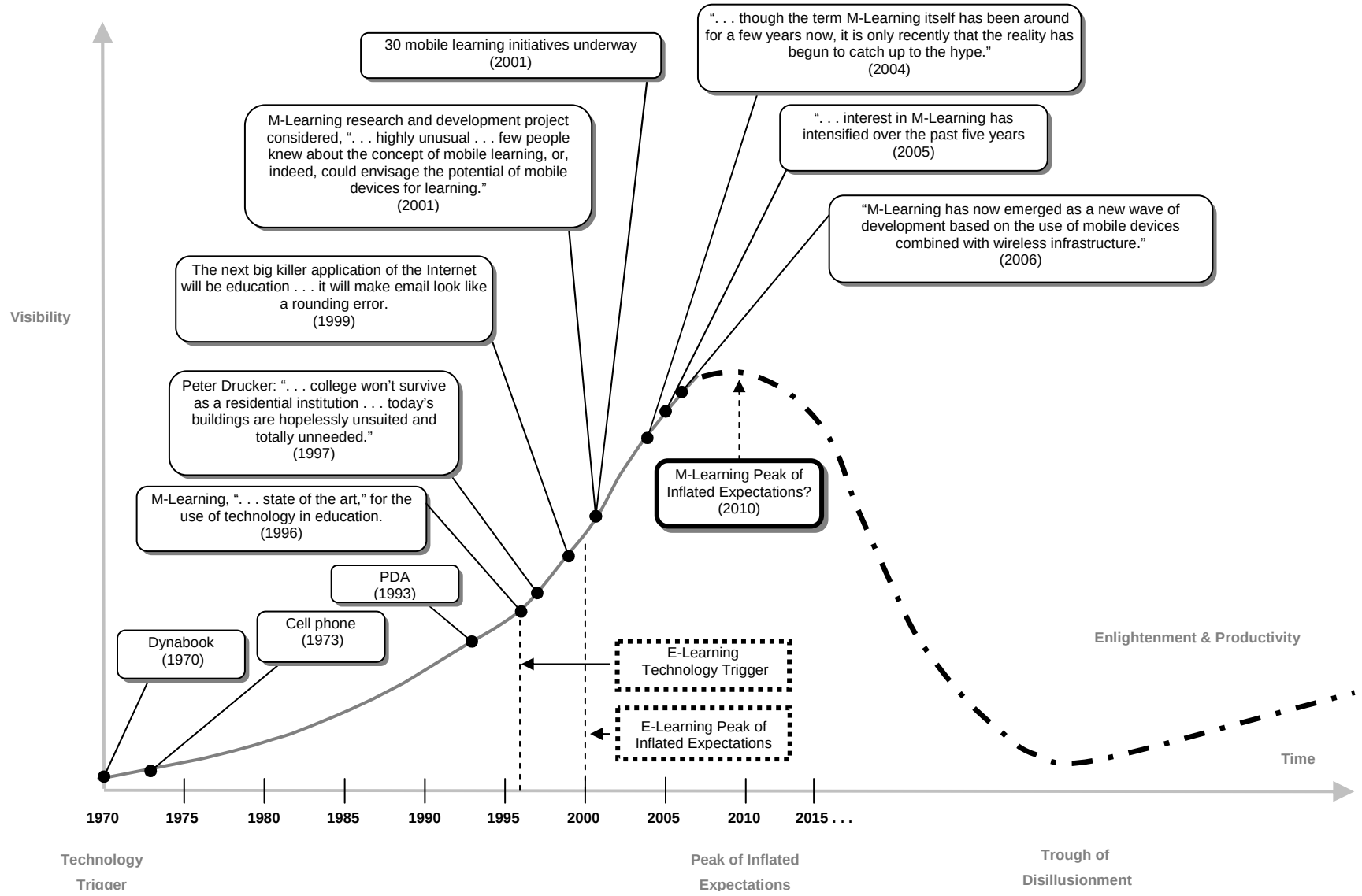

Figure 2.7. M-Learning Hype Cycle (Forecast). *Source:* Investigator.

The slow movement of M-Learning along the hype cycle to its peak has been caused in part by both scholars' and practitioners' continued (and vested) interest in M-Learning implementations and their excitement surrounding: 1) learning object delivery, 2) developing technologies, 3) a growing audience, 4) profitability and 5) the growing body of instructional design methodologies targeted specifically at learning through electronic transmission channels.[78]

In summary, during its infancy, through its growth, and on to its becoming a practical means of educating mobile learners, M-Learning has been a catalyst for:

1. A new use for small information appliances, making them much more than calendars, communication devices, or MP3 music players.

2. 'Attendance' at courses at a distance by mobile students; the devices are able to play asynchronous lectures as MP3 and AVI files on iPods, PDAs, cell phones, and smartphones.

3. The advent of learning objects that need not be formatted for peculiar devices. Students are able to synchronously send instant messages via cell phones, smartphones and other small information appliances to instructors during virtual office hours. They are able to further collaborate via laptop and other wireless devices.

4. The development of a hardware platform specifically designed for digital course content delivery, e.g. the Dynabook proposal and prototype.

78. For additional resources on Instructional Design for electronic learning see: Diana Laurillard, *Rethinking University Teaching*, 2nd ed. (New York: Routledge/Falmer, 2002); Ruth Colvin Clark and Richard E. Mayer, *e-Learning and the Science of Instruction* (San Francisco: Pfeiffer, 2003); Saul Carliner: *Designing E-Learning* (Baltimore: ASTD Press, 2002); Watkins and Corry, *E-Learning Companion*.

At one time almost excluded from professional development, the mobile learner is now able to close the gap on their brick and mortar colleagues through the growth of wireless connectivity common to most M-Learning small information appliances:

> . . . wireless communication has become ubiquitous . . . people are using their mobile phones anywhere: in cars, trains, planes, boats, cinemas, theaters, restaurants, bathrooms, at the beach, and on mountaintops. Possible uses of the devices are numerous and are growing rapidly – as they do so, sales continue to rise worldwide.[79]

Small information appliances capable of playing digitized content are an important factor in the M-Learning environment. Equally so is the availability of the learning object catalog. The virtual catalog of lecture notes, audio, video, PowerPoint slides, and other complimentary materials to classroom activity continue to grow and keep up with mobile learner demand. In 2002, the Massachusetts Institute of Technology (MIT) began a U.S. $100m initiative (OpenCourseWare – OCW) to make instructional materials for all of its more than 2,000 courses available free over the Internet.[80]

The OCW was supposed to be ". . . a limited online offering . . . not about online degree programs. It isn't even about online courses for which students can audit or enroll . . . it was intended to be nothing more than 'the content that supports an MIT

79. Milon Gupta, "GSM for Scuba Divers: Wireless communication Under Water," *Eurescom*, January 2003: 1, http://www.eurescom.de/message/messageMar2003/GSM_for_scuba_divers.asp (accessed September 5, 2007); Reed Business Information, "Factors Affecting Product Cost," http://www.purchasing.com/article/CA631794.html (accessed June 18, 2007).

80. Sarah Carr, "MIT will Place Course Materials Online," *The Chronicle of Higher Education*, April 20, 2001, http://chronicle.com/weekly/v47/i32/32a05403.htm (accessed May 23, 2007).

education'."[81] Since 2002, the initiative has grown in scope. OCW is being used by organizations/institutions such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the French University of Egypt for use in the delivery of accredited and audited courses.[82]

With M-Learning devices ubiquitous and the electronic course content library vast, a remaining concern is the means for hosting and delivery of course content. Commonly available post-secondary institution content-hosting platforms such as Blackboard, WebCT, Angel, Moodle, and IntraLearn, etc., are all capable of hosting M-Learning multimedia content (audio, video, text, etc.) with minimal setup. When systems administrators are reluctant to or cannot modify their virtual learning environments,[83] at least one free, online solution exists – Apple Computers' free hosting system called 'iTunes University (iTunes U)'. The platform was rolled out in May 2007 and pilot studies of iTunes began in 2004.[84]

The iTunes U interface is similar to that of the popular iTunes store which was introduced in 2003. The iTunes store affords users the opportunity to download rich multimedia content, store it on their computers, and synchronize it to their iPod or other compatible media player for mobile playback.

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81. Stephen Downs, "Courses vs. Content: Online Offerings from Major Institutions are not Created Equal," *eLearn Magazine*, http://www.elearnmag.org/subpage.cfm?section=opinion&article=82-1 (accessed October 18, 2007).

82. Ibid.

83. Niall Sclater, "Interoperability with CAA: Does it Work in Practice," under "Abstract," https://dspace.lboro.ac.uk:8443dspace/bitstream/2134/1890/1/sclater_n1.pdf (accessed September 21, 2007).

84. Apple Computer Corporation, "Apple Announces iTunes U on the iTunes Store," http://www.apple.com/pr/library/2007/05/30itunesu.html (accessed February 3, 2008).

The iTunes store was originally designed to provide users with access to audio files. It has since grown to be a repository for a wide variety of multimedia content to include audio books, videos, courseware, etc. This content is stored in a variety of means, to include 'podcasts'. In the case of courseware, podcasts provide the ability to automatically download only those course sessions that have not previously been accessed. This eases the burden of sifting through an entire semester of content to discover those lectures not previously listened to.

After downloading content, students can use it while untethered, 'attending' one, some, or all sessions of the course irrespective of time and place. iTunes U is an innovative, user-friendly service that lets students gain access to audio and video course materials anytime, anywhere.

By 2008, more than half of the nation's 500 top schools subscribed to the iTunes U service:[85]

> iTunes U has arrived, giving higher education institutions an ingenious way to get audio and video content out to their students. Presentations, performances, lectures, demonstrations, debates, tours, archival footage – school is about to become even more inspiring.[86]

Driven by a multimedia-thirsty population, manufacturers have produced inexpensive and novel multimedia players to satisfy the demand of not only learners but the general population. As the multimedia infrastructure and information appliance environment continues to provide an environment ripe for M-Learning, could it be the

85. Apple Computer Corporation, "iTunes U: The Campus that Never Sleeps," under "Join the Movement," http://www.apple.com/education/itunesu/index.html (accessed February 20, 2008).

86. Ibid., under "Education Evolves".

case that M-Learning will become an effective supplement to, or even a replacement for FTF?

In at least one instance M-Learning was found to an effective supplement to FTF. A 2006 European study included 1,000 participants: 1) traveler families across Scotland, 2) truck drivers and trainers in a large pharmaceutical company, 3) inner-city refugees, and 4) recent immigrants in Stockholm. The study was conducted in order to get a true sample of a widely diverse set of M-Learning participants in over twenty M-Learning trials across Europe, mostly in the United Kingdom:

> In almost all of these scenarios, we found that the learning worked best for both the learner and the tutor when it spanned the mobile device, and other media or group activities. Typically it was combined with: group activities, paper-based materials, other ICTs, [Information and Communication Technologies] and everything else tutors would normally do.[87]

The mixture of audio-only E-Learning delivered in an M-Learning environment combined with FTF activities such as group activities suggests that the study found a 'blended' environment to be most favorable. Other studies[88] suggest that rather than

87. Stead, "Moving Mobile into the Mainstream," under "Key Lessons," http://www.mlearn.org.za/CD/papers/Stead.pdf (accessed September 3, 2007).

88. D. Tripp and W. B. Roby, "Instructional Message Design Research 28. Auditory Presentations and Language Laboratories." in *Handbook of Research for Educational Communications and Technology*, ed. D. H. Jonassen (NY: Simon & Schuster Macmillan, 1996), 957-83. Auditory presentations can be at least as effective as live or print presentations and are practical alternatives to conventional instruction . . . radio instruction has been found to be at least as effective as conventional instruction . . . In general, comparisons of learning from audio and print have shown no difference; J.W. Bauer and L.L. Rezabek, "The Effects of Two-Way Visual Contact on Student Verbal Interactions During Teleconferenced Instruction," (proceedings of the AECT National Convention Research and Theory, 1992). No significant differences between the audio and traditional [face to face] group in either restricted or expanded thinking questions.

acting as an adjunct to an E-Learning environment comprising only audio, M-Learning is as equally effective as FTF; no significant difference in learning were found.[89]

Electronic course content creation, delivery, and access have matured since Dynabook. Objects can be developed, delivered, and consumed: 1) wirelessly, 2) by heterogeneous media, 3) on small information appliances – a first generation 80GB iPod multimedia player suitable for multimedia learning object playback measures 5.7" x 3.5" x 1.8" (L x W x H) and weighs 12 ounces[90] – and 4) by devices with computing power rivaling that of Dynabook era *super*computers. When Kay, et al. proposed Dynabook, the Seymour Cray CDC 7600 was widely hailed as the best sustained performance computing system. Its performance pales in comparison to today's smartphones which run at more than twice its speed. [91]

Since 2000, interest in M-Learning has intensified. An acute awareness of the need to satisfy a growing number of mobile learners has developed, and the portable technologies envisioned by Kay, et al. have become a reality. M-Learning has moved ". . . from being a theory, explored by academic and technology enthusiasts into a real and valuable contribution to learning."[92]

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89. Russell, *The No Significant Difference Phenomenon*.

90. Amazon.com. "Apple 80GB iPod Classic," http://www.amazon.com/Apple-80-iPod-classic-Black/dp/B000JLKIHA/ref=pd_bbs_1/104-8396446-3697558?ie=UTF8&s=electronics&qid=1190316083&sr=1-1#moreAboutThisProduct (accessed September 20, 2007).

91. Computermuseum Muenchum, "Terminal State of Scalar Computing: CDC7600," static.cray-cyber.org/Documentation/VectorComputing.ppt (accessed January 17, 2008).

92. Stead, "Moving Mobile into the Mainstream," under "Abstract".

2.4.1 M-Learning as an Education Platform

The need to fulfill demand for untethered anywhere anytime learning gave rise to M-Learning. M-Learning as an 'information mediator'[93] is situated between content and consumer, enabling the transmission of course information. Although designed specifically to distribute learning content, the M-Learning model is input independent, i.e. input to the model is not limited to learning objects – it is capable of distributing a variety of input, e.g. audio books, movies, music, etc. As such, M-Learning is a broadcast platform. Table 2.2 shows the components of a broadcast platform and maps them to the M-Learning model:

Table 2.2. Broadcast Platform Components

Components of a Broadcast Platform	M-Learning Broadcast Platform Characteristics
Content to broadcast	Learning objects
Means to broadcast	Wireless and/or wired networks
Target Devices	Small Information Appliances
Content *Consumers*	Learners

Sources: Broadcast-Technology.com, "EURO1080 European High Definition Channel, Belgium," http://www.broadcast-technology.com/projects/euro1080/ (accessed November 30, 2007); Microsoft, "Microsoft TV Technologies," http://www.microsoft.com/whdc/archive/TVtech.mspx (accessed November 30, 2007); IEEE Broadcast Technology Society, "Conferences", under "The History of the IEEE Broadcast Technology Society," http://www.ieee.org/organizations/society/bt/50years.html (accessed November 30, 2007).

As a specialized education broadcast platform, M-Learning accepts input in the form of learning content and transmits, or makes available, this content to a broad array of consumer devices: small information appliances (PDAs, smartphones, cell phones,

93. Leonardo Candela, Donatella Castelli, Pasquale Pagno, and Manuele Simi, "The Digital Library Mediator Layer," Istituto di Scienza e Tecnologie dell'Informazione, http://delos.cab.unipd.it/WorkFlow/ProcessInstances/1138196748.1/paper/Author_01 (accessed November 30, 2007).

etc.), small-form computers (laptop/notebook computers, etc.), and large-form devices (PCs, televisions, etc.) – it is output independent and thus unique in its ability to process a number of permutations and combinations of multimedia input and output.

M-Learning is one of many extant informant mediator platforms, including television and radio, etc. Each medium shares similar transmission channels – satellite, wired, and wireless networks, etc. It remains the case, however, that radio and television target specific output devices while M-Learning does not. Further differentiating M-Learning from other mediators is the specificity of its content. Although input/output agnostic, M-Learning by nature is a platform through which learning content is broadcast. If the M-Learning platform does not create and distribute course material, it becomes a generic mediator platform, not one of learning.

Instructional design methodologies have been developed to assist in the creation of M-Learning learning objects. These principles have been developed in an effort to ensure that the M-Learning platform delivers optimized learning objects as opposed to generic multimedia content. Following these principles increases the chances of successful execution of FTF to digitized content transformation.[94]

94. Roger C. Schank, Designing World-Class E-Learning: How IBM, GE, Harvard Business School, and Columbia University are Succeeding at e-Learning (New York: McGraw-Hill, 2002); Ruth Colvin Clark and Richard E. Mayer, e-Learning and the Science of Instruction (San Francisco: Pfeiffer, 2003); Saul Carliner, Designing E-Learning: Learn to Adapt your ISD Skills and Blend Solutions to Ensure Learning Sticks (Alexandria, VA: ASTD Press, 2006); Sharan B. Merriam and Rosemary S. Caffarella, Learning in Adulthood: A Comprehensive Guide (San Francisco: Jossey-Bass, 1999); Josie Taylor, Giancarlo Bo, Roberto Bernazzani, and Mike Sharples, "D4.2 – Best Practices for Instructional Design and Content Development for Mobile Learning," University of Birmingham, http://www.mobilearn.org/download/results/public_deliverables/MOBIlearn_D4.2_Final.pdf (accessed December 3, 2007).

One driving factor behind the time, effort, and money spent to create M-Learning design methodologies is a desire to minimize the number of occurrences where FTF is simply recorded and made available as-is to mobile learners. Ko and Rossen discuss this; "If you simply post your lectures and syllabus on the Web, you haven't necessarily created a viable tool for our students. The missing element here is instructional design."[95]

When FTF is digitized to create M-Learning content without taking into consideration the principles of M-Learning instructional design, M-Learning provides little added learning value. As an example of what M-Learning instructional principles must overcome, designers and developers must consider what ". . . the learner will be doing when the learner is using the courseware,"[96] e.g. will the learner be riding a train, driving a car, or walking along the street, etc.? FTF delivery methods do not have to take this into consideration. The whereabouts and actions of FTF instructors' students are known.

These principles of instructional design are similar to those governing 'traditional' FTF practices – the Socratic Method,[97] and case-based teaching[98], etc. As scholarly research and practitioner time continues to be devoted to the construction of principles of

95. Susan Ko and Steven Rossen. *Teaching Online: A Practical Guide* (Boston: Houghton Mifflin, 2004), 45.

96. Schank, Designing World-Class E-Learning, 91.

97. "A method of teaching by question and answer; used by Socrates to elicit truths from his students," Princeton.edu, "WordNet Search – 3.0" http://wordnet.princeton.edu/perl/webwn?s=socratic%20method (accessed December 3, 2007).

98. "With case-based teaching, students develop skills in analytical thinking and reflective judgment by reading and discussing complex, real-life scenarios," University of Michigan Center for Research on Learning and Teaching, "Teaching Strategies and Disciplinary Resources," http://www.crlt.umich.edu/tstrategies/teachings.html (accessed December 3, 2007).

M-Learning instructional design, credence is lent to the platform being a true education platform and not just a 'cool, novel, and fad' technology solution to the issues of distance learners.

Ko and Rossen[99] further discuss the conversion of FTF to M-Learning; "Putting your class online doesn't mean copying your lectures and syllabus word for word." Ko and Rossen not only recognize the M-Learning paradigm, but have published a variety of means to assist instructors in effectively using the platform.

Post-secondary institutions such as UNESCO and the French University of Egypt that utilize FTF-generated OCW materials for use in for-credit courses miss Ko and Rossen's point; borrowing publicly available FTF lecture slides, notes and syllabi and posting them on the Web does not make for an instructionally sound classroom environment – virtual or not.

"Pioneers in the instructional technology community have begun to grapple with mapping sound instructional principles to the technical attributes of learning object systems for education and training purposes," write Brenda Bannan-Ritland, et al. in 2002.[100] Wiley states; "Instructional design theory, or instructional strategies and criteria

99. Ko and Rossen, *Teaching Online*, 36.

100. Brenda Bannan-Ritland, Nada Dabbagh, and Kate Murphy, "Learning Object Systems as Constructivist Learning Environments: Related Assumptions, Theories, and Applications," In *The Instructional Use of Learning Objects*, ed. David A. Wiley (IN: Tichenor, 2002), 61-62.

for their application, must play a large role in the application of learning objects if they are to succeed in facilitating learning." [101]

In summary, there are still hurdles to leap as we 'mobilize' learning, but the attention thus far paid to M-Learning is encouraging. We should ensure that adequate and unique attention continues to be paid to M-Learning as a viable learning platform in and of itself as opposed to an extension of FTF.

2.4.2 Accessing and Delivering M-Learning Content

Investments in, and the widespread availability of wireless-fidelity (Wi-Fi) networks, the shrinking costs of data hosting/storage solutions, and the availability of a variety of inexpensive small information appliances have created an environment capable of providing learners with access to course content around the globe. The ubiquity of these components, all vital to M-Learning system implementations, have provided economies of scale that afford low cost of ownership and increasing levels of quality and fidelity.

In 2007 the United States saw nearly half (47%) of all adult Americans equipped with high-speed Internet connection at home. This figure was 30% in early 2005 and 42% in early 2006.[102] The proliferation of high speed broadband access bodes well for M-Learning. Even large electronic course objects can be downloaded quickly to PCs and transferred to mobile devices via Bluetooth, USB, firewire, or any other readily available

101. David A. Wiley, "Connecting Learning Objects to Instructional Design Theory: A Definition, A Metaphor, and a Taxonomy," In *The Instructional Use of Learning Objects*, ed. David A. Wiley (IN: Tichenor, 2002), 7.

102. The Pew Charitable Trusts (2007), "Broadband Adoption 2007," http://www.pewtrusts.org/our_work_ektid25474.aspx (accessed October 26, 2007).

means of connectivity. With the processing power and network connectivity capabilities of today's information appliances, it is even possible to download content directly, with no PC mediation required.

As an example, data can be transferred to any one of 233 million cell phones in use today across the United States; 2.1 billion are in use across the world. With a population of approximately 303 million people, United States cell phone penetration is approximately 77%. In 2007 SNL Kagan estimated that United States mobile phone penetration will be 100% by 2013.[103] This percentage has already been eclipsed in other countries – it is not uncommon for a single user to own several mobile, wireless-enabled devices.[104] Across the planet, mobile phone penetration is 32%.[105] Multimedia player penetration is also increasing. For example, in Q3 2006, over 8.7 million iPods were sold.[106]

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103. SNL Kagan Study, quoted in Engadget Mobile, "Study Suggests 100% Mobile Phone Penetration in the US by 2013," http://www.engadgetmobile.com/2007/08/26/study-suggests-100-mobile-phone-penetration-in-the-us-by-2013/ (accessed September 12, 2007).

104. W3 Consortium, "Compact HTML for Small Information Appliances," http://www.w3.org/TR/1998/NOTE-compactHTML-19980209/ (accessed September 20, 2007); Carolina Milanesi, Ann Liang, Tuong Huy Nguyen, Hugues J. De La Vergne, Nahoko Mitsuyama, and Annette Zimmermann, "Forecast: Mobile Devices, Worldwide, 2003-2011," The Gartner Group, http://www.gartner.com/DisplayDocument?id=510200&ref=g_sitelink (accessed August 23, 3007).

105. U.S. Census Bureau, "U.S. and World Population Clocks – POPClocks," http://www.census.gov/main/www/popclock.html (accessed October 26, 2007); Central Intelligence Agency, "The World Factbook," https://www.cia.gov/library/publications/the-world-factbook/rankorder/2151rank.html (accessed October 26, 2007).

106. Thomas Mennecke, "iPod Sales Help Apple Soar," *Slyck*, October 19, 2006, http://www.slyck.com/story1312.html (accessed October 18, 2007).

The PDA (introduced in 1990 as the Apple Newton) and smartphone (which emerged in 2000) demonstrate mixed sales forecasts through 2010 (see table 2.3 and figure 2.8).

Table 2.3. Handheld Computer Segment Sales Estimates 2000 – 2010 (projected)

Unit Sales ($ Millions)	2000	2003	2005	2006	2008	2010
U.S. Market						
PDA Sales	6.0	6.1	6.2	6.3	6.5	6.9
Smartphone Sales	-	0.3	3.8	7.6	16.4	26.4
Worldwide (WW) Market						
PDA Sales	11.4	13.0	13.5	13.98	14.8	16.0
Smartphone Sales	0.3	7.4	46.6	69.23	114.6	163.8

Source: Adapted from eTForecasts, "Worldwide PDA and Smartphone Forecast," under "Handheld Computer Sales Summary," http://www.etforecasts.com/products/ES_SP-PDA.htm#1.1 (accessed November 16, 2007).

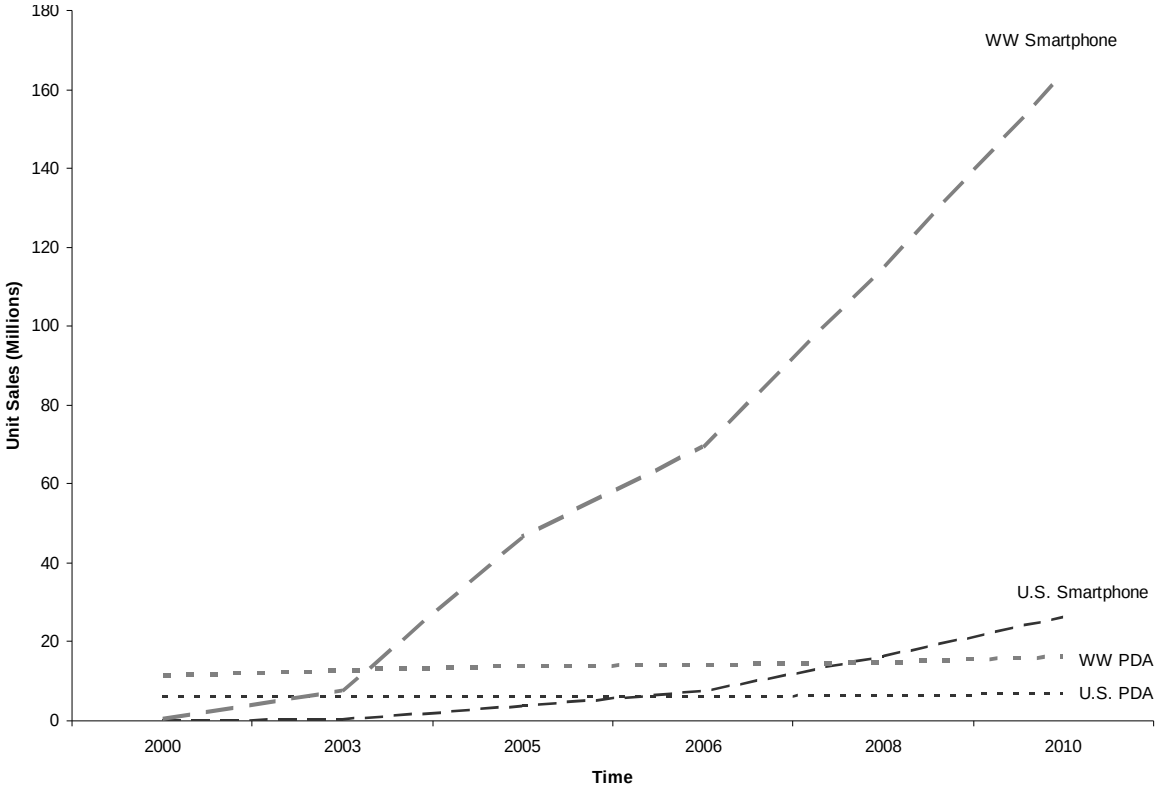

Figure 2.8. Handheld Computer Segment Sales Estimates (2000 – 2010 projected). *Source:* Adapted from eTForecasts, "Worldwide PDA and Smartphone Forecast," http://www.etforecasts.com/products/ES_SP-PDA.htm#1.1.

Worldwide PDA sales are estimated to remain flat for the 10 year period 2000-2010. During the same time, U.S. PDA sales are expected to rise by .9%. Meanwhile, it is anticipated that worldwide smartphone sales will explode. The U.S. smartphone market is expected to grow, but at not such an impressive rate.

In the small form factor PC market, May 2007 saw more notebooks sold than desktop computers – a milestone in PC history. Wireless connectivity also proliferated, ". . . one year ago [2006], over 20 percent of retail notebooks did not include wireless. Today, that number is less than 5 percent."[107]

Laptop computers equipped with Wi-Fi technologies that enable connectivity to local wireless 'hot spots' are another means through which untethered mobile students can stay connected to the virtual classroom. Recent advances in laptop connectivity afford users to connect using a broadband card (now offered as a built-in option) which connects to popular cellular providers' networks. For instance, a user might have a Sprint card installed in their computer which enables network connectivity from anywhere the network is accessible.

2.5 Research Question 1: Measuring Effectiveness through Student Performance

The first Research Question addressed in this study is; is the M-Learning MOD more or less effective than FTF?

To answer this question an assessment of effectiveness (grades on/across two quizzes) across delivery modes was performed. The model implemented to address the

107. c|net News.com, "PC Milestone – Notebooks Outsell Desktops," http://www.news.com/PC-milestone--notebooks-outsell-desktops/2100-1047_3-5731417.html (accessed October 31, 2007).

question was a dichotomous predictor (FTF, M-Learning), single outcome (Effectiveness) variable media comparison study (MCS) design (see figure 2.9).

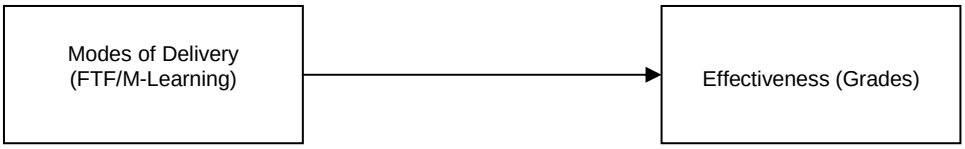

Figure 2.9. Media Comparison Model. *Sources:* Russell, *The No Significant Difference Phenomenon*; A. Tait, "Students and Attachment: The nature of electronic relationships," *Adult Learning* 11, no. 10 (2000): 20-22; R. Clark, "Media will never influence learning," *Educational Technology Research and Development* 42, no. 2 (1994): 21-29.*Research Question 2: Assessing IT Acceptance and Use through UTAUT*

The second Research Question addressed was; what are the factors that influence the acceptance and use of M-Learning?

Many competing models designed to account for IT user acceptance have been researched, designed, and implemented.[108] Drawing on ". . . robust theories from social psychology, notably the theory of reasoned action (TRA), the theory of planned behavior (TPB), diffusion of innovations (DOI) theory, and social cognitive theory (SCT),"[109] a model of individual acceptance of IT was presented by Agarwal in 2000 (see figure 2.10).

108. Venkatesh, et al., "User Acceptance of Information Technology," 426.

109. Agarwal, "Individual Acceptance of Information Technologies," 85-104.

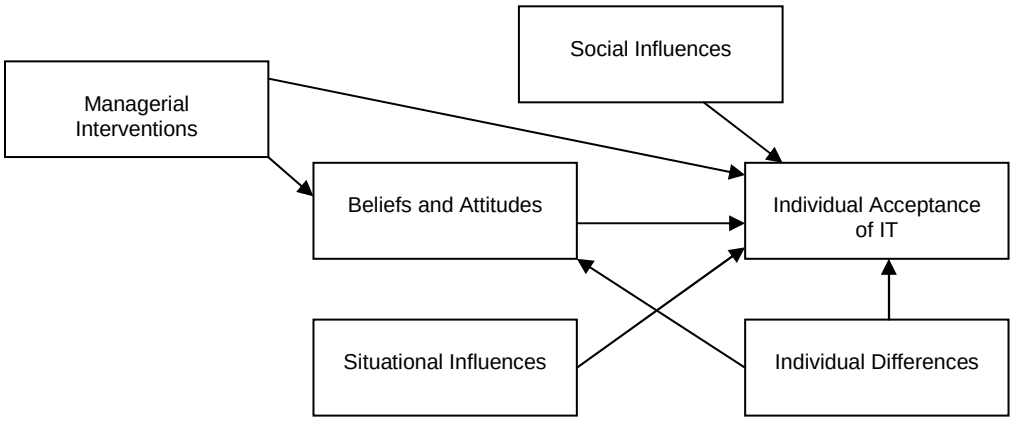

Figure 2.10. The Phenomenon of Individual Acceptance of IT. *Source:* R. Agarwal, "Individual Acceptance of Information Technologies," quoted in *Framing the Domains of IT Management: Projecting the Future through the Past*, ed. Robert W. Zmud (Cincinnati, OH: Pinnaflex Education Resources, 2000), 85-104.

In figure 2.11, Venkatesh, et al. summarize the basic concepts of the competing models. The underlying models have roots in IS, psychology, and sociology.

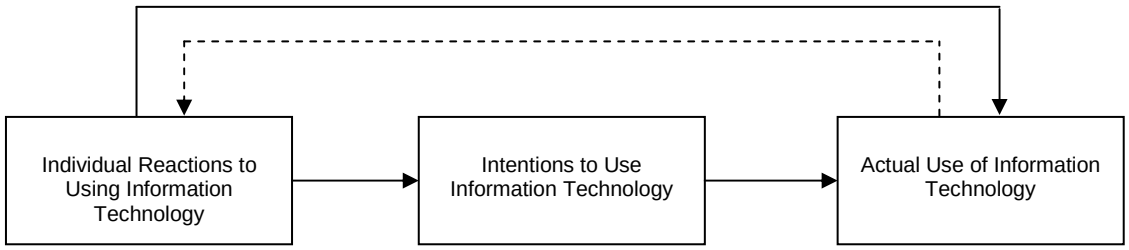

Figure 2.11. Basic Concept Underlying User Acceptance Models. *Source:* Venkatesh, et al., "User Acceptance of Information Technology," 427.

In 2003, Venkatesh, et al. identify eight prominent theoretical models designed to explore IT acceptance[110] (see table 2.4).

Table 2.4. Eight Primary Models of How and Why Individuals Adopt New Information Technologies

	Model	Abbreviation
1.	The Theory of Reasoned Action	TRA
2.	The Technology Acceptance Model	TAM/TAM2
3.	The Motivational Model (MM)	MM
4.	The Theory of Planned Behavior	TPB
5.	A Combined Technology Acceptance Model/Theory of Planned Behavior	C-TAM-TPB
6.	The Model of PC Utilization	MPCU
7.	Innovation Diffusion Theory	IDT
8.	Social Cognitive Theory	SCT

Source: Venkatesh, et al., "User Acceptance of Information Technology," 28-32.

Venkatesh et al. noted that researchers typically, 'pick and choose' constructs across models or take all constructs from a 'favorite' model. Executing the latter procedure causes researchers to "ignore the contributions from alternative models."[111] Venkatesh, et al. determine a need to review and synthesize the prominent models in order to ". . . progress toward a unified view of user acceptance."[112]

Their synthesis of the eight primary models results in UTAUT.[113] Appendix 2 depicts the eight models, provides an overview of each, and defines core constructs. Figure 2.12 presents Venkatesh, et al.'s UTAUT model and provides a brief description of each independent variable and the underlying models from which they are taken.

110. Venkatesh, et al., "User Acceptance of Information Technology": 28-32.

111. Ibid., 426.

112. Ibid.

113. Ibid., 28-32.

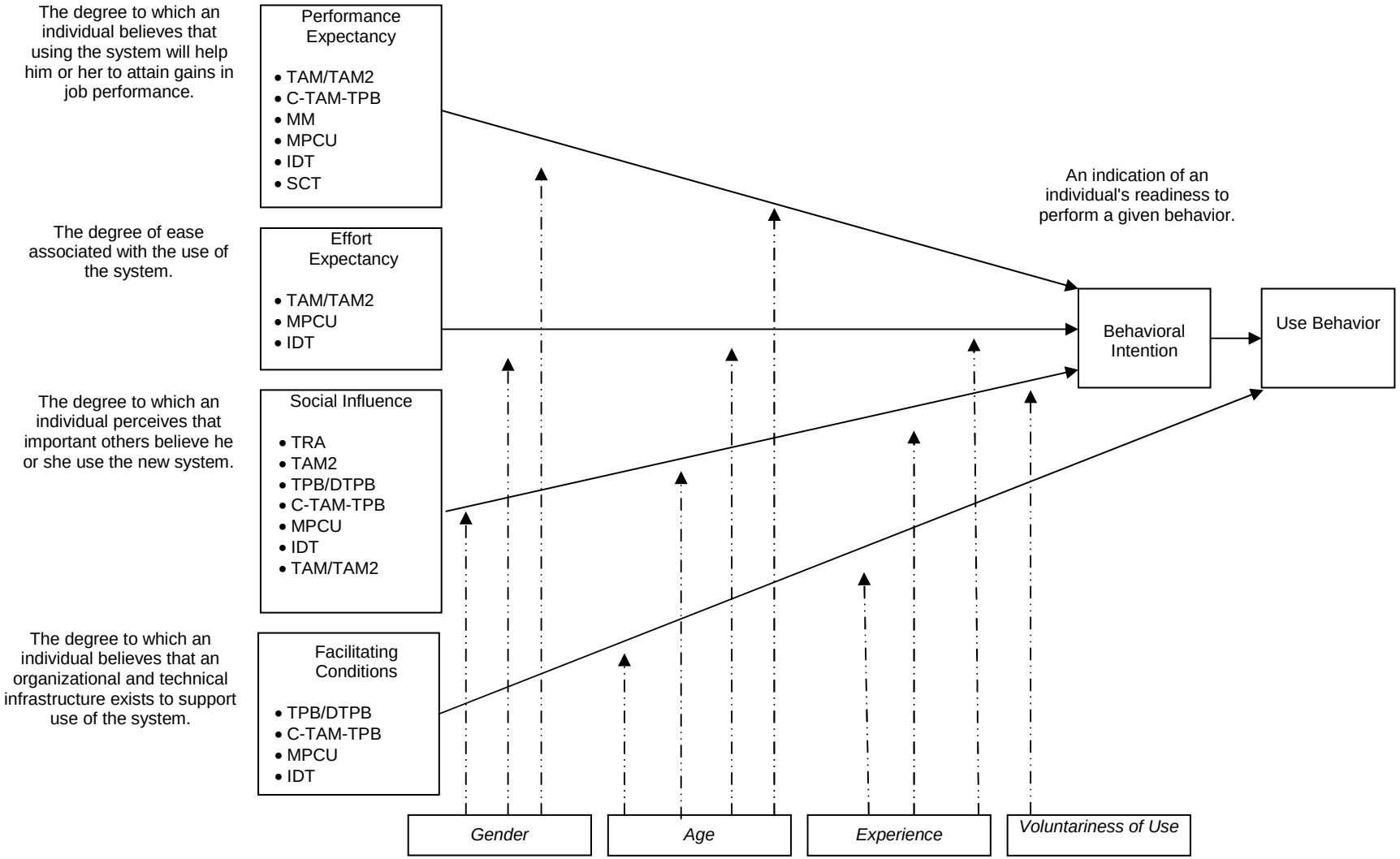

Figure 2.12. UTAUT Research Model. *Source:* Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 447.

Table 2.5 lists UTAUT Variables, Corresponding Models, Constructs and Definitions. Sections 2.5.1 through 2.5.1.8 explore each of the eight underlying models.

Table 2.5. UTAUT Variables, Corresponding Models, Constructs and Definitions

UTAUT Variable	Definition	Construct	Model
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance.	Perceived Usefulness	C-TAM-TPB TAM/TAM2
		Extrinsic Motivation	MM
		Job Fit	MPCU
		Relative Advantage	IDT
		Outcome Expectations	SCT
Effort Expectancy	The degree of ease associated with the use of the system.	Perceived Ease of Use	TAM/TAM2
		Complexity	MPCU
		Ease of Use	IDT
Social Influence	The degree to which an individual perceives that important others believe he or she use the new system.	Subjective Norm	TRA TAM2 TPB/DTPB C-TAM-TPB
		Social Factors	MPCU
		Image	IDT
Facilitating Conditions	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.	Perceived Behavioral Control	TPB/DTPB C-TAM-TPB
		Facilitating Conditions	MPCU
		Compatibility	IDT

Source: Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 448-454.

2.5.1 UTAUT Theoretical Underpinnings

2.5.1.1 Theory of Reasoned Action (TRA)[114]

In the UTAUT model, Social Influence captures the concept of the Subjective Norm construct embodied in TRA (see table 2.6).

Table 2.6. UTAUT Variable Capturing TRA Construct

UTAUT Variable	Definition	Construct
Social Influence	The degree to which an individual perceives that important others believe he or she use the new system.	Subjective Norm

Source: Venkatesh, et al., "User Acceptance of Information Technology," 448-454.

Applied to IS, TRA maintains that individuals would use computers if they could see that there would be positive benefits (outcomes) associated with using them.[115] The TRA model (see figure 2.13) is ". . . a widely studied model from social psychology . . . concerned with the determinants of consciously intended behaviors."[116] It ". . . argues that people consider the consequences of their actions before they decide as to whether or

114. H. Eagly and S. Chaiken, *The Psychology of Attitudes* (Fort Worth: Harcourt Brace Jovanovich College Publishers, 1993); Appalachian State University and York University, "Theories Used in IS Research: Theory of Reasoned Action," http://www.istheory.yorku.ca/theoryofreasonedaction.htm (accessed December 14, 2007).

115. Deborah R. Compeau and Christopher A. Higgins, "Computer Self-Efficacy: Development of a Measure and Initial Test," *MIS Quarterly* 19, no. 2 (June 1995): 189.

116. F. D. Davis, R. P. Bagozzi, and P. R. Warshaw, "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models", *Management Science* 35, no. 8 (1989): 983; M. Fishbein and I. Ajzen, *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research* (Reading, MA: Addison-Wesley, 1975); I. Ajzen and M. Fishbein, *Understanding Attitudes and Predicting Social Behavior* (Englewood Cliffs, NJ: Prentice-Hall, 1980).

not to engage in a given behavior."[117] The model assumes that most actions of social relevance are under ". . . volitional control." [118]

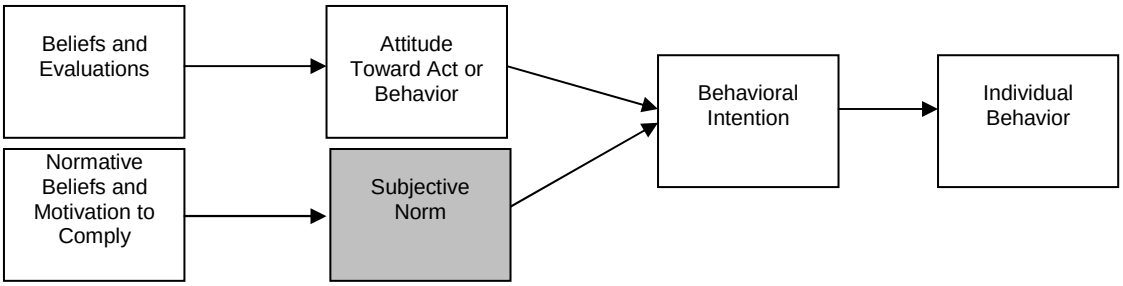

Figure 2.13. Theory of Reasoned Action Model. *Sources:* Fishbein and Ajzen, *Belief, Attitude, Intention, and Behavior*; Davis, Bagozzi, and Warshaw, "User acceptance of computer technology," 984.

The TRA model demonstrates that an Individual's Behavior (performance of a specified behavior) is driven by their Behavioral Intention to perform the behavior. In turn, Behavioral Intention is driven by the person's Attitude Toward a given Act or Behavior and their Subjective Norm; ". . . the person's perception that most people who are important to him think he should or should not perform the behavior in question."[119]

2.5.1.2 Technology Acceptance Models (TAM)

In the UTAUT model, Performance Expectancy, Effort Expectancy, and Social Influence capture the concepts of the Perceived Usefulness, Perceived Ease of Use, and Subjective Norm constructs embodied in TAM and TAM2 (see table 2.7).

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117. Edward Mahinda, "State of the Art Literature Review on Intrinsic Systems Criteria by which Users can Assess System Performance," PhD diss., New Jersey Institute of Technology, 2005: 10, http://brianwhitworth.com/mahinda-sota.doc. (accessed December 20, 2007).

118. Ibid.

119. Fishbein and Ajzen, Belief, Attitude, Intention, and Behavior, 302.

Table 2.7. UTAUT Variables Capturing TAM and TAM2 Constructs

UTAUT Variable	Definition	Construct	Model
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance.	Perceived Usefulness	TAM/TAM2
Effort Expectancy	The degree of ease associated with the use of the system.	Perceived Ease of Use	TAM/TAM2
Social Influence	The degree to which an individual perceives that important others believe he or she use the new system.	Subjective Norm	TAM2

Source: Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 448-454.

2.5.1.2.1 TAM

In the TAM model, two beliefs are of primary relevance to UTAUT: Perceived Usefulness and Perceived Ease of Use (see figure 2.14).[120]

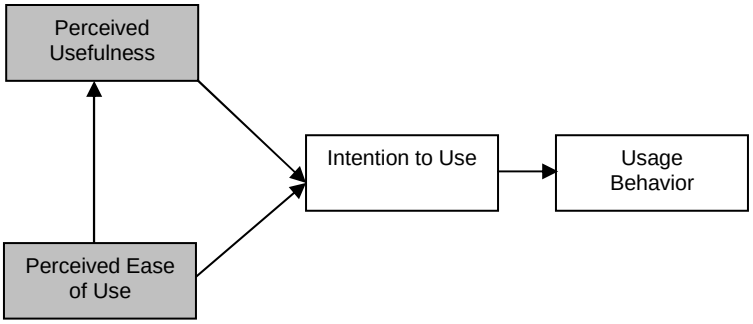

Figure 2.14. Technology Acceptance Model. *Source:* Viswanath Venkatesh and Fred D. Davis, "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies," *Management Science* 46, no. 2 (February 2000):188.

TAM theorizes that the effects of external variables such as System Characteristics and Developmental Process and Training, etc. on Intention to Use are mediated by Perceived Usefulness and Perceived Ease of Use. In addition, TAM

120. Davis, Bagozzi, and Warshaw, "User Acceptance of Computer Technology," 985.

theorizes that Perceived Usefulness is also influenced by Perceived Ease of Use because, other things being equal, ". . . the easier the system is to use the more useful it can be."[121]

TAM, ". . . an adaptation of the Theory of Reasoned Action (TRA) specifically tailored for modeling user acceptance of IS,"[122] is focused on determining general computer acceptance. It is both ". . . parsimonious and theoretically justified."[123] At its nucleus, TAM is designed to provide insight on user behavior regarding technologies designed for end-users.

TAM is similar to TRA in that computer usage is determined by Behavioral Intention to Use. A key difference is that in TAM, Behavioral Intention to use is jointly determined by Perceived Ease of Use and Perceived Usefulness. This implies that ". . . all else being equal, people form intentions to perform behaviors toward which they have a positive effect."[124]

2.5.1.2.2 TAM2

Using TAM as a starting point, TAM2 incorporates additional theoretical constructs that span social influence processes, to include Subjective Norm. As such, TAM2 is a ". . . theoretical extension of [TAM]."[125] It explains Perceived Usefulness and

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121. Venkatesh and Davis, "A Theoretical Extension," 187.

122. Appalachian State University and York University, "Theories Used in IS Research: Technology Acceptance Model," http://www.istheory.yorku.ca/Technologyacceptancemodel.htm (accessed December 14, 2007); Davis, Bagozzi, and Warshaw, "User Acceptance of Computer Technology," 985.

123. Davis, Bagozzi, and Warshaw, "User Acceptance of Computer Technology," 985.

124. Ibid., 986.

125. Venkatesh and Davis, "A Theoretical Extension," 186.

Usage Intentions in terms of Social Influence and Cognitive Instrumental Processes (see figure 2.15).

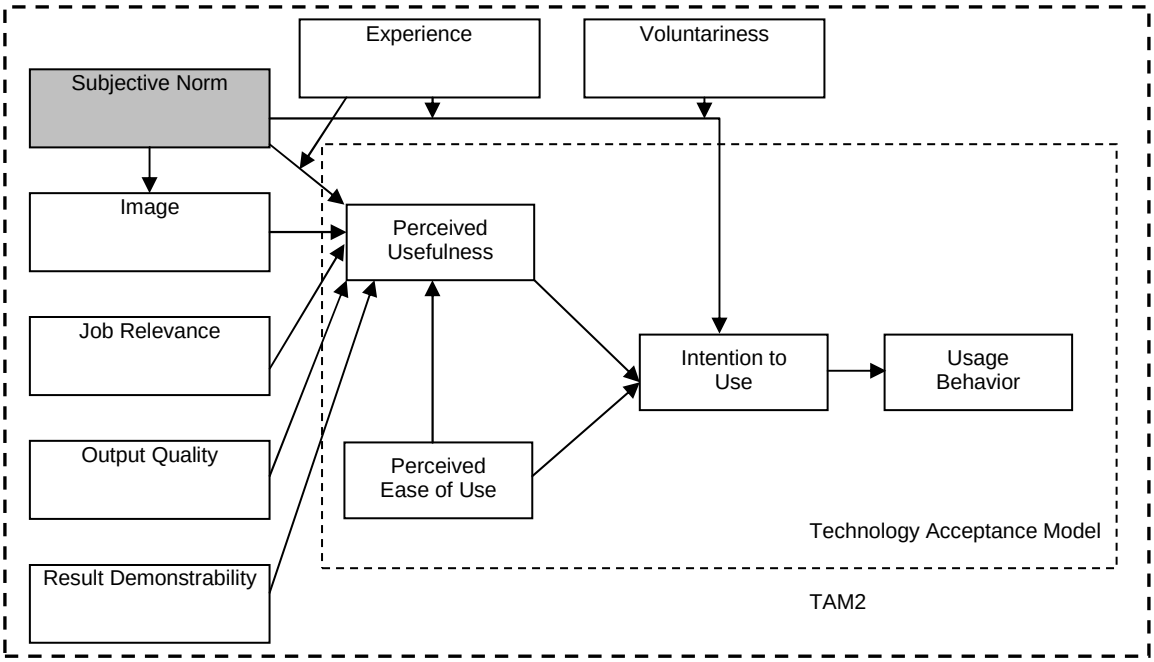

Figure 2.15. Technology Acceptance Model 2 – An Extension of the Technology Acceptance Model. *Source:* Venkatesh and Davis, "A Theoretical Extension," 188.

Venkatesh and Davis hypothesize that Subjective Norm will have a positive direct effect on Perceived Usefulness. The results of their research indicate the effect of Subjective Norm on Intention to Use is consistent with this hypothesis. When ". . . Usage was mandatory, Subjective Norm did have a direct effect on Intention to Use."

In contrast, where Usage was voluntary Subjective Norm had no direct effect on intention over and above what was explained by Perceived Usefulness and Perceived Ease of Use (TAM). TAM2 ". . . reflects the impacts of three interrelated social forces

impinging on an individual facing the opportunity to adopt or reject a new system."[126] These forces are:

- Image: ". . . the degree to which use of an innovation is perceived to enhance one's . . . status in one's social system."[127]
- Subjective Norm: (consistent with TAM and TRA)
- Voluntariness: "The extent to which potential adopters perceive the adoption decision to be non-mandatory."[128]

Venkatesh and Davis[129] hypothesized that Subjective Norm would have a positive direct effect on Perceived Usefulness. They found that the effect of Subjective Norm on Intention to Use was consistent with this hypothesis; when ". . . Usage was mandatory, Subjective Norm did have a direct effect on Intention to Use."[130] In contrast, where Usage was voluntary Subjective Norm had no direct effect on Intention over and above what was explained by Perceived Usefulness and Perceived Ease of Use (TAM).

2.5.1.3 Motivational Model (MM)

In the UTAUT model, Performance Expectancy captures the concept of the Extrinsic Motivation construct embodied in the MM (see table 2.8).

126. Ibid., 187.

127. G. C. Moore and I. Benbasat, "Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation," *Information Systems Research* 2 **(**1991): 195.

128. Ibid., 188.

129. Venkatesh and Davis, "A Theoretical Extension," 186-204.

130. Ibid., 199.

Table 2.8. UTAUT Variable Capturing MM Construct

UTAUT Variable	Definition	Construct	Model
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance.	Extrinsic Motivation	MM

Source: Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 448-454.

Davis, et al. ask, "Do people use computers at work more because they are useful [e.g. Perceived Usefulness – Extrinsic Motivator] or because they are enjoyable [e.g. Enjoyment – Intrinsic Motivator] to use?"[131] Finding no previous research on the impact of Enjoyment on Usage Intentions they subsequently turned to psychology research which supports general motivation theory as an explanation for Behavior (see figure 2.16).

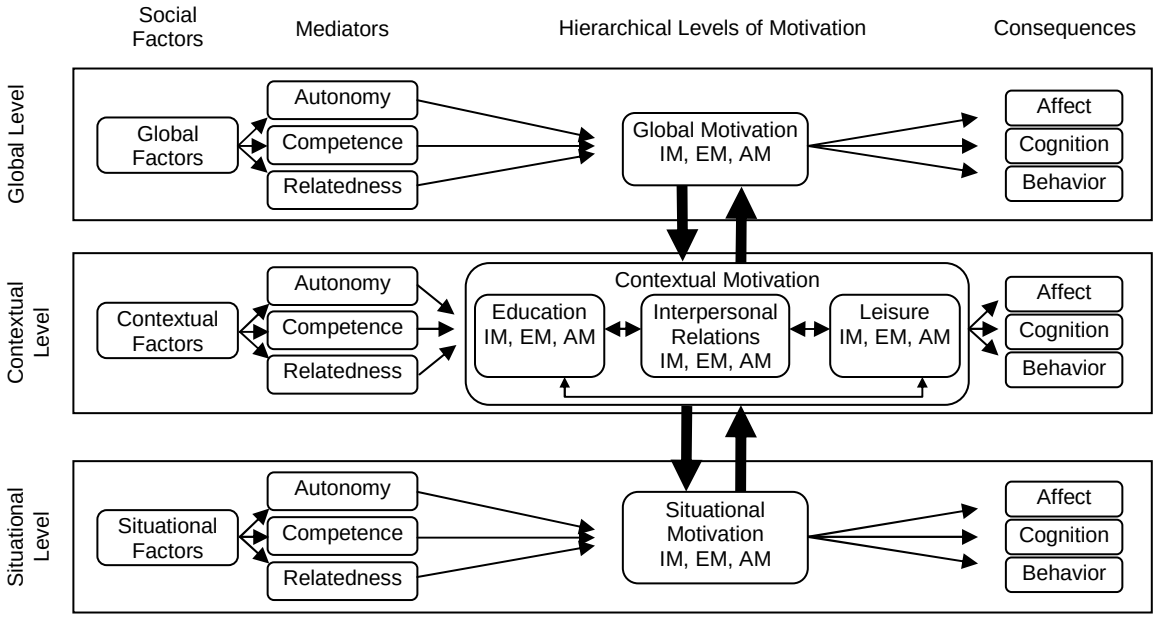

Figure 2.16. The Hierarchical Model of Intrinsic (IM) and Extrinsic Motivation (EM). AM: Amotivation. *Sources:* R. J. Vallerand, "Toward a Hierarchical Model of Intrinsic and Extrinsic Motivation," *Advances in Experimental Social Psychology*, ed. M.P. Zanna (New York: Academic Press, 1997): 271-360; R. J. Vallerand, "Deci and Ryan's Self-Determination Theory: A View from the Hierarchical Model of Intrinsic and Extrinsic Motivation," *Psychological Inquiry* 11, no. 4 (2000): 312-319.

131. Fred D. Davis, Richard P. Bagozzi, Paul R. Warshaw, "Extrinsic and Intrinsic Motivation to Use Computers in the Workplace," *Journal of Applied Social Psychology* 22, no. 14 (July 1992); 1111.

The Hierarchical Model ". . . takes into consideration the different types of motivation (Intrinsic and Extrinsic) at three levels of generality, how these various motivations are related, as well as the determinants and consequences of these motivational representations."[132]

Davis, et al. operationalize Extrinsic Motivation as ". . . the performance of an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions."[133]

In summary, their results indicate that people's ". . . intentions to use computers in the workplace are influenced mainly by their perceptions of how useful the computers are for improving their job performance [Extrinsic Motivation], and secondarily by the degree of Enjoyment they experience in using the computers per se [Intrinsic Motivation]." Of note is that the researchers found that ". . . enhancing Enjoyability may increase the adoption of marginal or unproductive systems, or encourage unproductive or frivolous overuse of systems where less time spent using the computer would get the job done adequately."[134]

132. Vallerand, "Deci and Ryan's Self-Determination Theory," 312.

133. Davis, Bagozzi and Warshaw, *Extrinsic and Intrinsic Motivation*, 1112.

134. Ibid., 1125.

Figure 2.17 presents a 1996 motivational model specific to microcomputer usage prepared by Igbaria, Parasuraman, and Baroudi.[135]

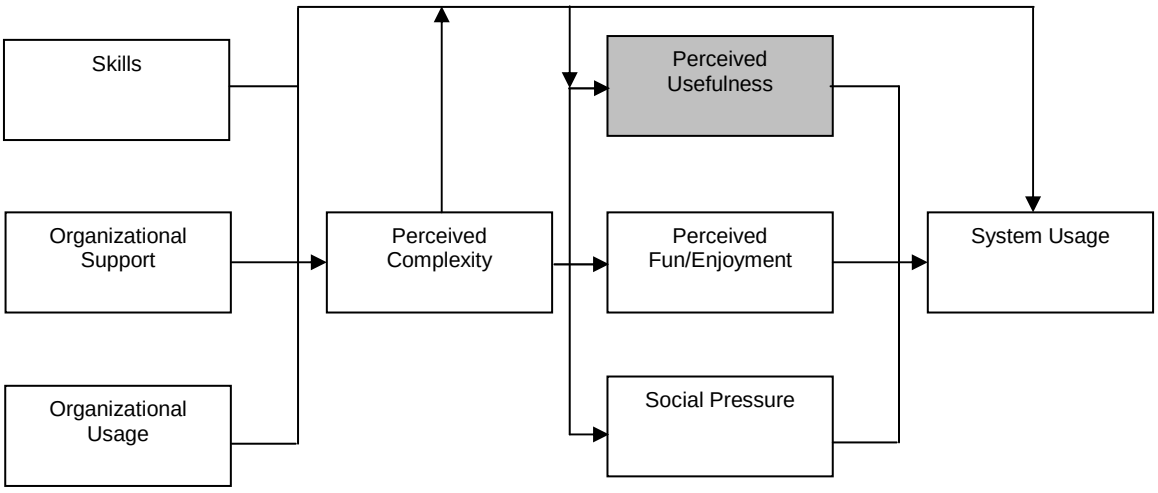

Figure 2.17. A Motivational Model of Microcomputer Usage. *Source:* Igbaria, Baroudi, and Parasuraman, "A Motivational Model," 130.

The importance of Perceived Usefulness as a motivating factor derives from the TRA and TAM models; ". . . Perceived Usefulness affects computer Usage due to the reinforcement value of outcomes."[136] The results of Igbaria et al.'s research demonstrate the ". . . relative contribution of Perceived Usefulness, Perceived Enjoyment, and Social Pressure [the person's perception of the social pressures put on them to perform or not perform the behavior in question[137]] to variation in microcomputer Usage."[138] Perceived Usefulness – an Extrinsic Motivator – was found to be the principal motivator in microcomputer Usage as opposed to Perceived Fun – an Intrinsic Motivator.

135. Magid Igbaria, Saroj Parasuraman, and Jack J. Baroudi, "A Motivational Model of Microcomputer Usage," *Journal of Management Information Systems* 13, no. 1 (Summer 1996): 127-143.

136. Igbaria, Baroudi, and Parasuraman, "A Motivational Model," 130.

137. Azjen and M. Fishbein, *Understanding Attitudes and Predicting Social behavior* (Englewood Cliffs, NJ: Prentice-Hall, 1980), 6.

138. Igbaria, Baroudi, and Parasuraman, "A Motivational Model," 140.

Davis, et al. and Igbaria, et al. agree that Perceived Usefulness and Perceived Enjoyment contribute significantly to user motivation to adopt and use a technology. Although slightly differing in their conclusions (Davis et al. did not consider Social Pressure in their model), both studies found the Motivational Model to be useful in researching Extrinsic Motivation and its impact on individuals' Use and Perception of microcomputers and software applications.

2.5.1.4 Planned Behavior Theories

In the UTAUT model, Social Influence and Facilitating Conditions capture the concepts of the Subjective Norm and Perceived Behavioral Control constructs embodied in TPB/DTPB (see table 2.9).

Table 2.9. UTAUT Variables Capturing TPB/DTPB Constructs

UTAUT Variable	Definition	Construct	Model
Social Influence	The degree to which an individual perceives that important others believe he or she use the new system.	Subjective Norm	TPB/DTPB
Facilitating Conditions	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.	Perceived Behavioral Control	TPB/DTPB

Source: Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 448-454.

2.5.1.4.1 Theory of Planned Behavior (TPB)

The TPB model (see figure 2.18) posits that individual behavior is driven by ". . . [b]ehavioral Intentions." TPB extends the TRA model to account for conditions where individuals do not have complete control over their behavior. This is achieved through the addition of a third construct; Perceived Behavioral Control. Perceived Behavioral Control is defined as ". . . the perceived ease or difficulty of performing [a] behavior."[139]

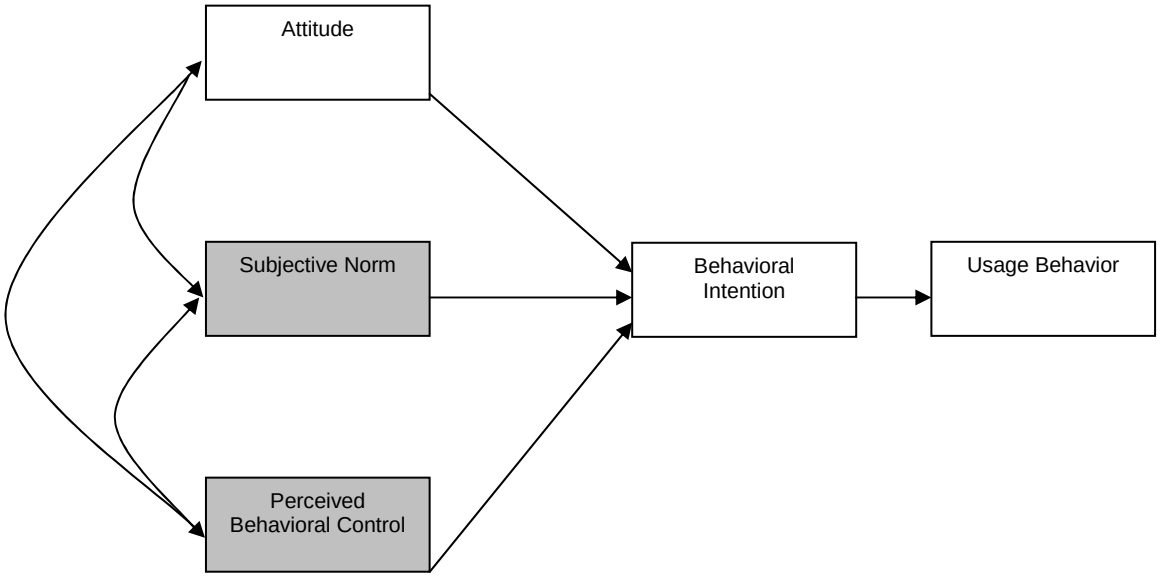

Figure 2.18. Theory of Planned Behavior Model. *Sources:* Ajzen, "The Theory of Planned Behavior," 182; Shirley Taylor and Peter A. Todd, "Understanding Information Technology Usage: A Test of Competing Models," *Information Systems Research* 6, no. 4 (1995): 146.

TPB demonstrates that ". . . behavioral Intentions are a function of an individual's attitude toward the behavior, the Subjective Norms [Subjective Norm] surrounding the performance of the behavior, and the individual's Perception of the ease with which the behavior can be performed [Perceived Behavioral Control]."[140]

139. Ajzen, "The Theory of Planned Behavior," *Organizational Behavior and Human Decision Processes* 50, no. 2 (1991): 188.

Taylor and Todd found that the intentions to perform behaviors, together with Perceived Behavioral Control, account for significant variance in actual behavior. In the context of IS research, this variable is replaced by perceptions of internal and external constraints on behavior.[141]

Although Ajzen suggests that the link between Behavior and Behavioral Control outlined in the model should be between Behavior and *actual* Behavioral Control rather than *perceived* Behavioral Control, the difficulty of assessing Actual Control has led to the use of Perceived Control as a proxy. [142]

2.5.1.4.2 Decomposed Theory of Planned Behavior (DTPB)

In terms of predicting intention, DTPB is identical to TPB.[143] In creating the DTPB model, Taylor and Todd argue for ". . . the value of decomposed belief structures that can potentially be applied to a variety of research settings." [144] Comparing DTPB's explanatory and predictive performance to that of both TAM and TPB, they arrived at the model depicted in figure 2.19.

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140. Appalachian State University and York University, "Theories Used in IS Research: Theory of Planned Behavior"; Eagly and Chaiken, *The Psychology of Attitudes*.

141. Shirley Taylor and Peter A. Todd, "Understanding Information Technology Usage: A Test of Competing Models," *Information Systems Research* 6, no. 4 (1995): 144-176; A. Icek, *From intention to Actions: A Theory of Planned Behavior, in Action Control: From Cognition to Behavior* (New York: Springer Verlag, 1985).

142. Ajzen, "The Theory of Planned Behavior," 179-211; Appalachian State University and York University, "Theories Used in IS Research: Theory of Planned Behavior".

143. Venkatesh, et al,. "User Acceptance of Information Technology," 429.

144. Taylor and Todd, "Understanding Information Technology Usage," 149.

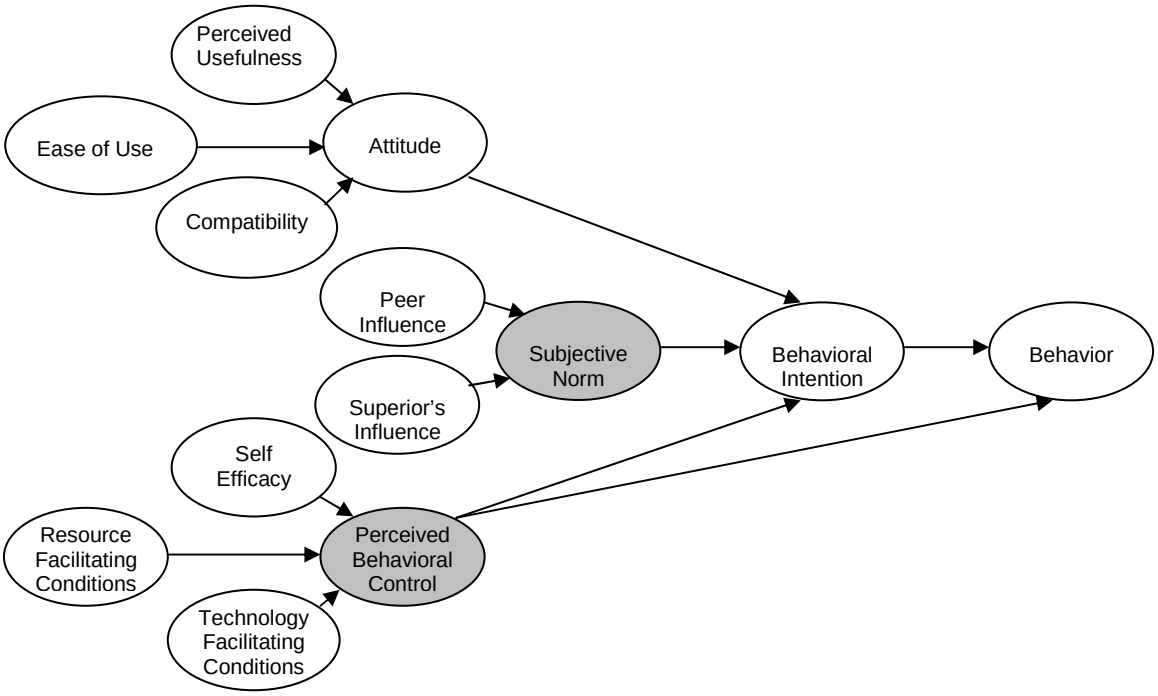

Figure 2.19. Decomposed Theory of Planned Behavior Model. *Source:* Taylor and Todd, "Understanding Information Technology Usage," 146.

In contrast to TPB, DTPB aims to provide a fuller understanding of Behavioral Intention through a focus on factors that are likely to influence systems use through the application of both design and implementation strategies.[145] The model explores the dimensions of Subjective Norm and Perceived Behavioral Control by ". . . decomposing them into specific belief dimensions."[146]

DTPB's advantages are similar to TAM including its capability to identify specific beliefs that may influence IT usage. Not present in TAM are the additional factors incorporated into DTPB. These include Influence of Significant Others and

145. Ibid., 144.

146. Ibid., 147.

Perceived Ability and Control. These factors have, however, been shown to be important determinants of Behavior.[147]

Upon comparing TPB and DTPB, Taylor and Todd find that DTPB provides increased explanatory power for Intentions as compared with TPB, although it is considerably less parsimonious than TAM. [148] The study also discussed that because of its unidimensional belief constructs, DTPB provides greater diagnostic value than TPB, provides greater insight into the factors that influence IT usage, and suggests beliefs that can be targeted by designers or managers interested in influencing system use.

2.5.1.5 Combined Technology Acceptance Model and Theory of Planned Behavior (C-TAM-TPB)

In the UTAUT model, Performance Expectancy and Social Influence capture the concepts of the Perceived Usefulness and Subjective Norm constructs embodied in C-TAM-TPB (see table 2.10).

Table 2.10. UTAUT Variables Capturing C-TAM-TPB Constructs

UTAUT Variable	Definition	Construct	Model
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance.	Perceived Usefulness	C-TAM-TPB
Social Influence	The degree to which an individual perceives that important others believe he or she use the new system.	Subjective Norm	C-TAM-TPB

Source: Adapted from Venkatesh, et al., "User Acceptance of Information Technology", 448-454.

147. Ajzen, "The Theory of Planned Behavior," 179-211.

148. Taylor and Todd, "Understanding Information Technology Usage," 144-176.

This hybrid model (see figure 2.20) – (also known as Augmented TAM[149]) – combines the TAM Perceived Usefulness construct with the predictors of TPB (Attitude Toward Behavior, Subjective Norm, and Perceived Behavioral Control).[150]

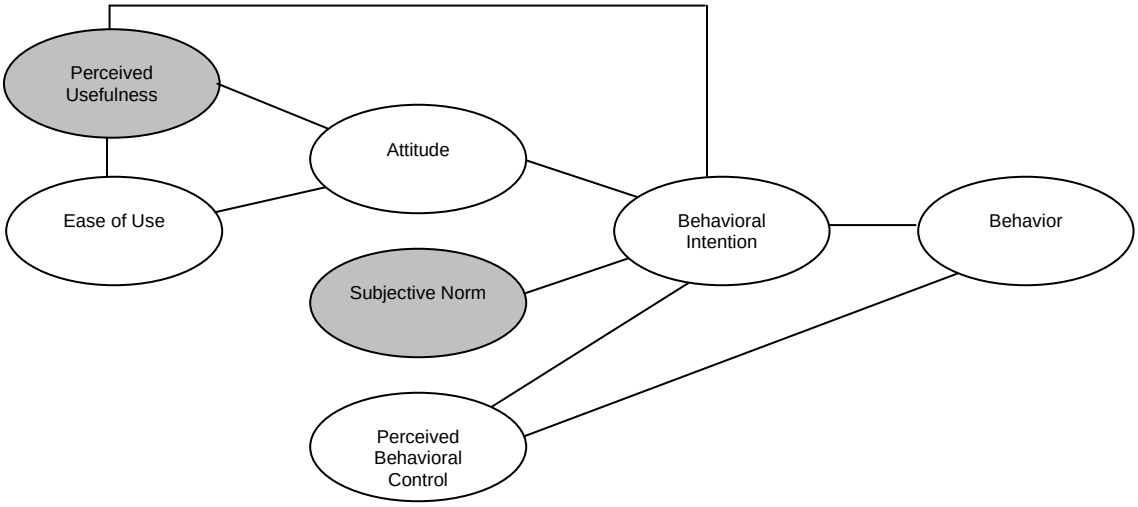

Figure 2.20. Combined TAM and TPB Model (C-TAM-TPB). *Source:* Taylor and Todd, "Assessing IT Usage," 562.

Social and control factors are included in C-TAM-TPB due to their demonstrated influence on IT usage.[151] Through a review of prior studies and the literature, Taylor and Todd determine that empirical tests of existing IS usage models generally focus on: 1) systems already in use, or 2) systems with which study participants were familiar. In light of this, the researchers found it ". . . unclear as to: 1) whether models such as TAM are predictive of behavior for inexperienced users and, more importantly 2) whether the

149. Taylor and Todd, "Assessing IT Usage," 562.

150. Ibid., 561-570; Venkatesh, et al., "User Acceptance of Information Technology," 429.

151. Taylor and Todd, "Assessing IT Usage," 562; Ajzen, "The Theory of Planned Behavior," 179-211.

determinants of IT usage are the same for experienced and inexperienced users of a system."[152]

Specific to the C-TAM-TPB constructs reviewed here, Taylor and Todd hypothesized:

- Subjective Norm to Behavioral Intention: The relative influence of Subjective Norm on Intentions is expected to be stronger for potential users with no prior Experience since they are more likely to rely on the reactions of others in forming their intentions.[153]

- Perceived Usefulness and Attitude to Behavioral Intention: Beliefs and attitudes correlate more strongly with behavior for people who have had direct experience with an object, suggesting a stronger influence of perceived usefulness and attitude on BI and subsequent behavior for experienced users.[154]

The researchers note in their limitations that the study focuses on a student setting where Subjective Norms and Perceived Behavioral Control may operate differently than in workplace settings. In summary, they find no significant relationship between inexperienced and experienced users for the relationship Subjective Norm to Behavioral Intention. There was no significant relationship between Perceived Usefulness to Attitude. Perceived Usefulness to Intention was significant at $p<.01$.

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152. Taylor and Todd, "Assessing IT Usage," 561.

153. R. E. Burnkrant, and A. Cousineau, "Informational and Normative Social Influence in Buyer Behavior," *Journal of Consumer Research* 2, no. 3, (December 1975): 206-215; J. Hartwick and H. Barki, "Explaining the Role of User Participation in Information System Use," *Management Science* 40, no. 4 (April 1994): 440-465.

154. Eagly and Chaiken, *The Psychology of Attitudes*; R. H. Fazio and M. Zanna, "Attitudinal Qualities Relating to the Strength of the Attitude Behavior Relationship," *Journal of Experimental Social Psychology* 14, no. 4 (July 1978): 398-408; D. T. Regan and M. Fazio, "On the Consistency Between Attitudes and Behavior: Look to the Method of Attitude Formation," *Journal of Experimental Social Psychology* 13, no. 1 (January 1977): 28-45.

2.5.1.6 Model of PC Utilization (MPCU)

In the UTAUT model, Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions capture the concepts of the Job Fit, Complexity, Social Factors, and Facilitating Conditions constructs embodied in MPCU (see table 2.11).

Table 2.11. UTAUT Variables Capturing MPCU Constructs

UTAUT Variable	Definition	Construct	Model
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance.	Job Fit	MPCU
Effort Expectancy	The degree of ease associated with the use of the system.	Complexity	MPCU
Social Influence	The degree to which an individual perceives that important others believe he or she use the new system.	Social Factors	MPCU
Facilitating Conditions	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.	Facilitating Conditions	MPCU

Source: Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 448-454.

Derived largely from Triandis'[155] theory of human behavior (see figure 2.21), the MPCU model (see figure 2.22) presents a competing perspective to that proposed by TRA and TPB.

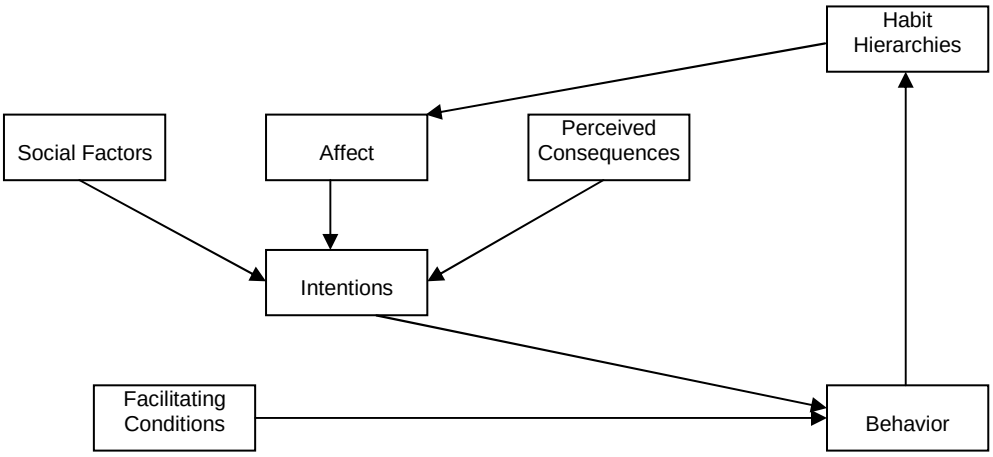

Figure 2.21. Factors Influencing Behavior (a subset of the model proposed by Triandis). *Source:* H.C. Triandis, "Values, Attitudes, and Interpersonal Behavior," in *Nebraska Symposium on Motivation, 1979: Beliefs, Attitudes, and Interpersonal Behavior*, (Lincoln, NE: University of Nebraska Press, 1980), 195-259, quoted in Ronald L. Thompson, Christopher A. Higgins and Jane M. Howell, "Personal Computing: Toward a Conceptual Model of Utilization," *MIS Quarterly* 15, no. 1 (March 1991): 127.

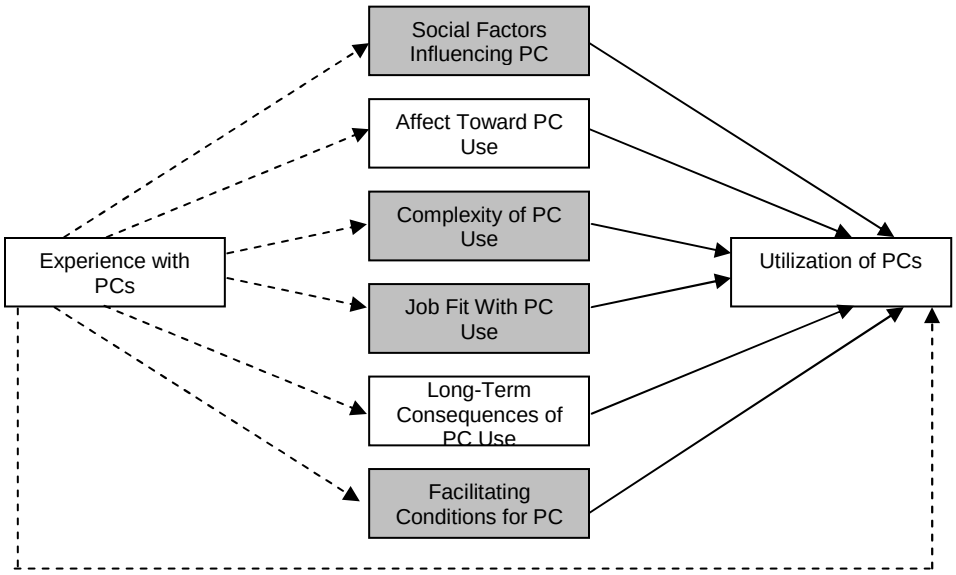

Figure 2.22. Model of PC Utilization – Factors Influencing the Utilization of Personal Computers (solid lines illustrate the original model – broken lines indicate Thompson et al.'s hypothesized direct and indirect influence of experience). *Source:* Thompson, Higgins and Howell, "Personal Computing," 172.

155. Harry Charalambos Triandis, *Interpersonal Behavior* (Monterey, CA: Brooke/Cole, 1977).

Most notably, Thompson, et al. refine Triandis' model of behavioral influence in order to predict PC utilization. Below, Thompson defines constructs salient to MPCU. Hypotheses are italicized, results are underlined.

- Social Factors: Individual's internalization of the reference groups' subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations.[156]

  H1: There will be a positive relationship between Social Factors concerning PC use and the Utilization of PCs

  Supported

- Complexity: Degree to which an innovation is perceived as relatively difficult to understand and use.[157]

  H3: There will be a negative relationship between the Perceived Complexity of a PC and the Utilization of PCs

  Significant negative relationship

- Job Fit: Extent to which an individual believes that using a PC can enhance the performance of his or her job (e.g., obtaining better information for decision making or reducing the time required for completing important job tasks). [158]

  H4: There will be a positive relationship between perceived Job Fit and the Utilization of PCs

  Supported

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156. H. C. Triandis, *Attitude and Attitude Change* (New York: John Wiley and Sons, 1971), 210.

157. E. M. Rogers and F. F. Shoemaker, *Communication of Innovations: A Cross-Cultural Approach* (New York: Free Press, 1971), 154.

158. Ibid., 129.

- Facilitating Conditions: Objective factors 'out there' in the environment that several judges or observers can agree make an act easy to accomplish,[159] e.g. provision of support for users of PCs may be one type of Facilitating Condition that can influence PC Utilization.[160]

  H6: There will be a positive relationship between Facilitating Conditions and for PC use and the Utilization of PCs

  Small, negative influence – (not statistically significant)

Thompson notes that the nature of the MPCU model makes it particularly suited to such predictions. The model enables the ability to ". . . predict Individual Acceptance and use of a range of information technologies;"[161]

In summary, the model seeks to predict Use Behavior rather than Intention. Additionally, Thompson, et al.'s study, an initial test of Triandis' theory within the IS context, finds evidence that variables including Social Factors, Complexity, and Job-Fit have significant effects on PC use.

2.5.1.7 Innovation Diffusion Theory (IDT)

In the UTAUT model, Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions capture the concepts of the Relative Advantage, Ease of Use, Image, and Compatibility constructs embodied in IDT (see table 2.12).

159. Venkatesh, et al., "User Acceptance of Information Technology," 430.

160. Thompson, Higgins, and Howell, "Personal Computing," 129.

161. Venkatesh, et al., "User Acceptance of Information Technology," 430.

Table 2.12. UTAUT Variables Capturing IDT Constructs

UTAUT Variable	Definition	Construct	Model
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance.	Relative Advantage	IDT
Effort Expectancy	The degree of ease associated with the use of the system.	Ease of Use[162]	IDT
Social Influence	The degree to which an individual perceives that important others believe he or she use the new system.	Image[163]	IDT
Facilitating Conditions	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.	Compatibility	IDT

Source: Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 448-454.

Grounded in sociology, variables determining the rate of adoption of innovations (see figure 2.23) have been applied since the 1960s to study a variety of innovations, ranging from agricultural tools to organizational innovation.[164]

162. Moore and Benbasat, "Development of an Instrument," 195.

163. Ibid.

164. Everett M. Rogers, *Diffusion of Innovations* (New York: Free Press, 1962); Louis G. Tornatzky and Katherine J. Klein, "Innovation Characteristics and Innovation Adoption –Implementation: A Meta-Analysis of Findings," *IEEE Transactions on Engineering Management* 29, no. 1 (1982): 28-45.

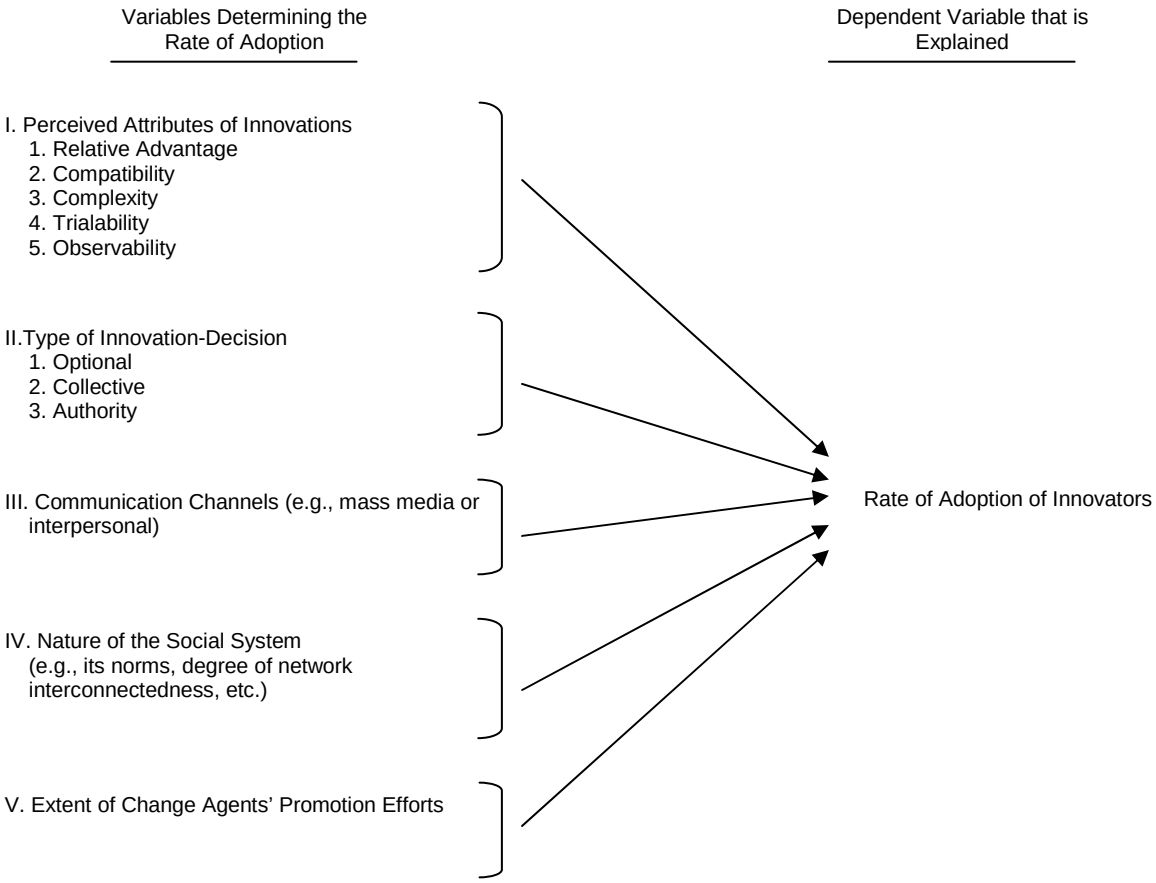

Figure 2.23. Variables Determining the Rate of Adoption of Innovations. *Source:* Rogers, *Diffusion of Innovations*, 207.

Rogers[165] defines diffusion as:

> . . . the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication, in that the messages are concerned with new ideas. *Communication* is a process in which participants create and share information with one another in order to reach a mutual understanding.[166]

165. Rogers, Diffusion of Innovations.

166. Ibid., 5-6; Moore and Benbasat, "Development of an Instrument".

He identifies five general attributes of innovations that influence adoption:

1. Compatibility: The degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters.[167]

2. Complexity: The degree to which an innovation is perceived as difficult to understand and use.[168]

3. Observability: The degree to which the results of an innovation are visible to others.[169]

4. Relative Advantage: The degree to which an innovation is perceived as being better than its precursor.[170]

5. Trialability: The degree to which an innovation may be experimented with on a limited basis.[171]

Moore and Benbasat[172], in their research designed to develop an instrument to measure the perceptions of adopting an information technology innovation – personal workstations (PWS) – add two new constructs based on Davis' TAM model:

1. Perceived Ease of Use: The degree to which the PWS is easy to learn and use.

2. Perceived Usefulness: The degree to which an individual believes that using a particular system would enhance his or her job performance.[173]

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167. Rogers, Diffusion of Innovations, 15.

168. Ibid., 16.

169. Ibid.

170. Rogers, *Diffusion of Innovations*; Moore and Benbasat, "Development of an Instrument," 195.

171. Ibid.

172. Moore and Benbasat, "Development of an Instrument," 197.

173. Ibid.

Moore and Benbasat, based on the work of Tornatzky and Klein[174], add the Image construct:

- Image: The degree to which the use of the PWS enhances one's image or status within the organization

Addressing the model, Moore and Benbasat find; ". . . Rogers' (TAM) definitions are based on perceptions of the innovation itself, and not on perceptions of actually using the innovation." [175] Moore and Benbasat argue that ". . . it is not the potential adopters' perceptions of the innovation itself, but rather their perceptions of using the innovation that are key to whether the innovation diffuses." [176]

Arguing that Rogers focuses on innovations and not on their *use*, Moore[177] addresses Rogers' approach in subsequent research targeted at the application of Rogers' model to end user computing. In doing so, Moore recasts the perceived characteristics of innovations in order to better represent the *use* of an innovation. For example; ". . . the definition of Relative Advantage [the degree to which an innovation is perceived as being *better* than its precursor] needs only simple rewording to be defined as, '. . . the degree to which *using* its precursor'".[178]

174. Tornatzky and Klein, "Innovation Characteristics," 28-45.

175. Moore and Benbasat, "Development of an Instrument," 196.

176. Ibid.

177. Gary C. Moore, "End User Computing and Office Automation: A Diffusion of Innovations Perspective," *Information Systems Research* 25, no. 3 (1987): 214-235

178. Moore and Benbasat, "Development of an Instrument," 196.

In this way, all characteristics were recast by Moore and Benbasat in terms of the potential adopters use, trial or observation of the innovation. They subsequently label the resulting recasts as Perceived Characteristics of Innovating (PCI).

Continuing to recast Rogers' perceived characteristics of innovating, they pave the way for the model to be used in terms of potential adopters' ". . . use, trial or observation of the innovation,"[179] rather than focusing on the innovation itself.

2.5.1.8 Social Cognitive Theory (SCT)

In the UTAUT model, Performance Expectancy captures the concept of the Outcome Expectations construct embodied in SCT (see table 2.13).[180]

Table 2.13. UTAUT Variables Capturing SCT Constructs

UTAUT Variable	Definition	Construct	Model
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance.	Outcome Expectations	SCT

Source: Venkatesh, et al., "User Acceptance of Information Technology," 448-454.

SCT is based on the premise that, "Environmental influences such as Social Pressures or unique Situational Characteristics, Cognitive and other personal factors including personality as well as demographic characteristics, and behavior are reciprocally determined." [181]

179. Ibid.

180. Venkatesh, et al., "User Acceptance of Information Technology," 448-454.

181. Compeau and Higgins, "Computer Self-Efficacy," 191.

SCT favors a conception of interaction based on triadic reciprocality (see figure 2.24).

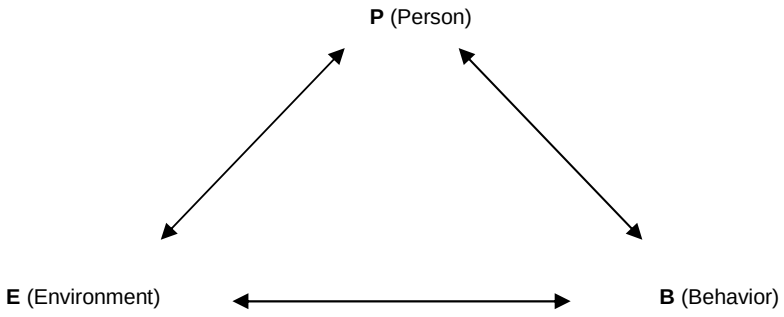

Figure 2.24. Schematization of the Relations between the Three Classes of Determinants in Triadic Reciprocal Causation (Triadic Reciprocality). *Source:* Bandura, *Social Foundations of Thought and Action*, 24.

In the SCT model, reciprocal determinism is identified. Behavior; Personal, and Environmental influences operate interactively as determinants of each other. 'Reciprocal' refers to the ". . . mutual action between each causal factor."[182]

> "Many factors are often needed to create a given effect. Because of the multiplicity of interacting influences, the same factor can be a part of different blends of conditions that have different effects." [183]

Since 1970 there has been a dramatic increase in the amount of research on computer based information systems implementations.[184] Organizations and researchers turned their attention to this area when it was found that the adoption of new technologies

182. Bandura, Social Foundations of Thought and Action, 23-24.

183. Ibid.

184. H. C. Lucas Jr., "Empirical Evidence for a Descriptive Model of Implementation," *MIS Quarterly* 2, no. 2 (June 1978): 27.

was not living up to expectations.[185] Gaining an understanding of the factors that influence individuals' use of information technology became a focus of MIS research.

TRA was one of the first theoretical perspectives to gain widespread acceptance in this area. Maintaining that ". . . individuals would use computers *if* they could see that there would be positive benefits (outcomes) associated with using them,"[186]

Despite the efforts of researchers employing TRA, a growing recognition remained that additional explanatory variables above and beyond the model were needed.[187] In response, Compeau and Higgins turned to the research of Albert Bandura[188] and his widely accepted, empirically validated model of individual behavior – SCT.

In 1995 they applied SCT to IS and focused on ". . . the role of individuals' beliefs about their abilities to competently use computers." [189] Their research culminated in the model shown in figure 2.25.

185. Compeau and Higgins, "Computer Self-Efficacy," 189.

186. Ibid.

187. Thompson, Higgins and Howell, "Personal Computing; Toward a Conceptual Model of Utilization," 125-143; J. Webster and J. J. Martocchio, "Microcomputer Playfulness: Development of a Measure with Workplace Implications," *MIS Quarterly* 16, no. 2 (June 1992): 210-226.

188. Bandura, Social Foundations of Thought and Action.

189. Compeau and Higgins, "Computer Self-Efficacy," 189.

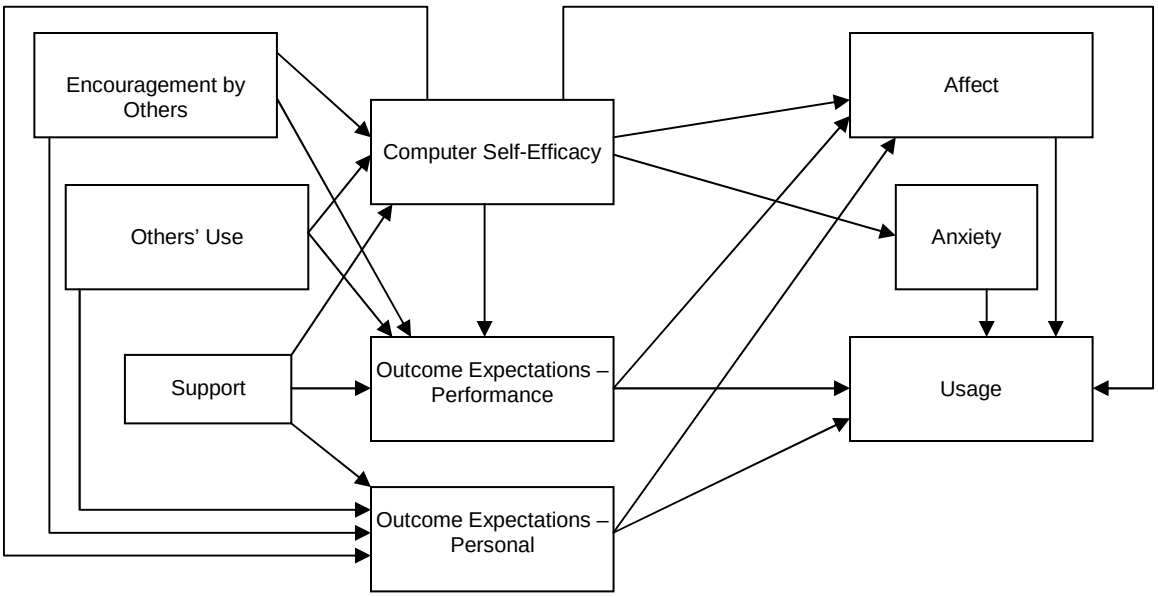

Figure 2.25. Compeau-Higgins Computer Self-Efficacy Research Model (revised). *Source:* Compeau and Higgins, "Computer Self-Efficacy," 194.

Included in their hypotheses was an analysis of Outcome Expectation – a construct aligned with the concept of Performance Expectancy in UTAUT.[190] Under the heading, 'outcome expectations (performance/personal), they pose the following research hypothesis:

> H12: The higher the individual's outcome expectations, the higher his/her use of computers.

The results of their research indicated that ". . . Self-Efficacy adds to our understanding of why people use computers, over and above concepts like Outcome Expectations, Anxiety, and Affect."[191] Additionally, they found that:

190. Ibid.

191. Ibid., 207.

> . . . [the] study provides support . . . for the Social Cognitive Theory perspective on computing behavior. Self-efficacy was found to play an important role in shaping individuals' feelings and behaviors. Individuals in this study with high Self-Efficacy used computers more, derived more enjoyment from their use, and experienced less computer anxiety.[192]

Also based on SCT and as a follow-up to their 1995 research, in 1999 Compeau, Higgins and Huff 1999 present the model in figure 2.26.

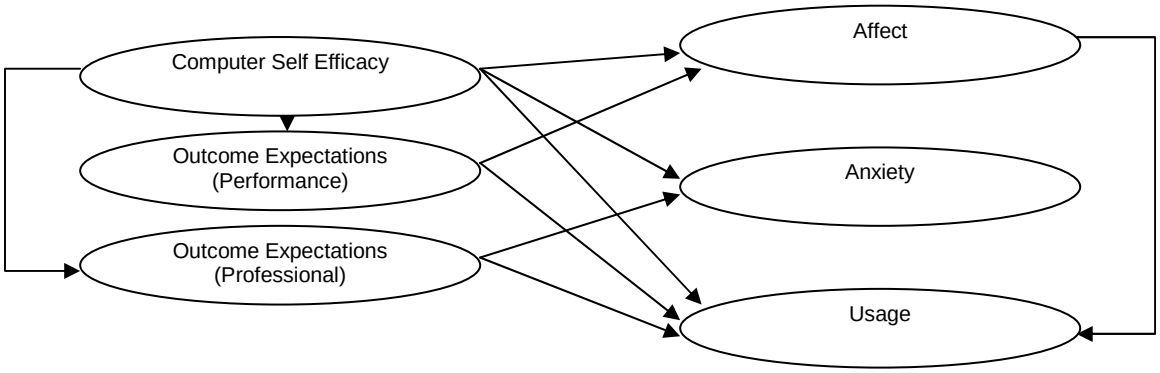

Figure 2.26. Research Model - Compeau, Higgins and Huff. *Source:* Deborah Compeau, Christopher A. Higgins, Sid Huff, "Social Cognitive Theory and Individual Reactions to Computing Technology: A Longitudinal Study," *MIS Quarterly* 23, No. 2 (June 1999): 145-158.

The model, also based on SCT, provides additional research into Outcome Expectations. It was developed specifically to test the construct as well as Computer Self-Efficacy, Affect, and Anxiety on computer usage.

They note that while TAM and DOI focus almost exclusively on Beliefs and Outcomes regarding studied technologies, SCT and TPB provide insight into other beliefs that might influence behavior, independent of perceived outcomes.

Their longitudinal study, based on Self-Efficacy and Outcome Expectations, is designed to provide an understanding whether the influences of these constructs are short

192. Compeau and Higgins, "Computer Self-Efficacy," 203.

or long in duration in nature. The model includes two dimensions of Outcome Expectations – Performance and Personal:

1. Performance: Those associated with improvements in job performance (efficiency and effectiveness) associated with using computers.[193]

2. Personal: Expectations of change in image or status or to expectations of rewards, such as promotions, raise, or praise.[194]

Similar to their previous research, included in their hypotheses is an analysis of Outcome Expectation – salient to both UTAUT and SCT. They pose the following research hypotheses:

H1: The higher the individual's computer self efficacy, the higher his/her performance related outcome expectations.[195]

H2: The higher the individual's computer Self Efficacy, the higher his/her personal Outcome Expectations.[196]

Their findings indicate significant relationships between Outcome Expectations (Performance and Personal) and Computer Self Efficacy at $p<.001$, consistent with previous studies.[197] Included in their results:

193. Compeau, Higgins, and Huff, "Social Cognitive Theory," 147.

194. Ibid.

195. Bandura, N.E. Adams, and J. Beyer, "Cognitive Processes Mediating Behavioral Change," *Journal of Personality and Social Psychology* 35, no. 3 (1977): 125-139; N. E. Betz and G. Hackett, "The Relationships of Career-related Self-efficacy Expectations to Perceived Career Options in College Women and Men," *Journal of Counseling Psychology* 28, no. 5 (1981): 399-410; Stumpf, Brief, and Hartman, "Self efficacy Expectations," 91-108.

196. Bandura, Adams, and Beyer, "Cognitive Processes Mediating Behavioral Change," 125-139; Betz and Hackett, "The Relationships of Career-Related Self-efficacy," 399-410; Stumpf, Brief, and Hartman, "Self efficacy Expectations," 91-108.

197. Compeau and Higgins, "Computer Self-Efficacy," 189-211.

> . . . this study confirms many of the results of earlier cross-sectional study and strengthen the findings by showing the continuing predictive capability of self-efficacy and performance related outcome expectations.[198]

198. Compeau, Higgins, and Huff, "Social Cognitive Theory," 153.

Chapter 3 Methodology

3.1 Introduction

This study employed two models: 1) the Performance model (see figure 3.1), and 2) the Unified Theory of Acceptance and Use of Technology (UTAUT) model (see figure 3.2), to answer two Research Questions:

1. Is the M-Learning MOD more or less effective than FTF?
2. What are the factors that influence the acceptance and use of M-Learning Information Systems?

Figure 3.1. The Performance Model. *Sources:* Adapted from Russell, *The No Significant Difference Phenomenon*; R. Clark, "Media Will Never Influence Learning," *Educational Technology Research and Development* 42, no. 2 (1994): 21-29; A. Tait, "Students and Attachment: The Nature of Electronic Relationships," *Adult Learning* 11, no. 10 (2000): 20-22; Investigator.

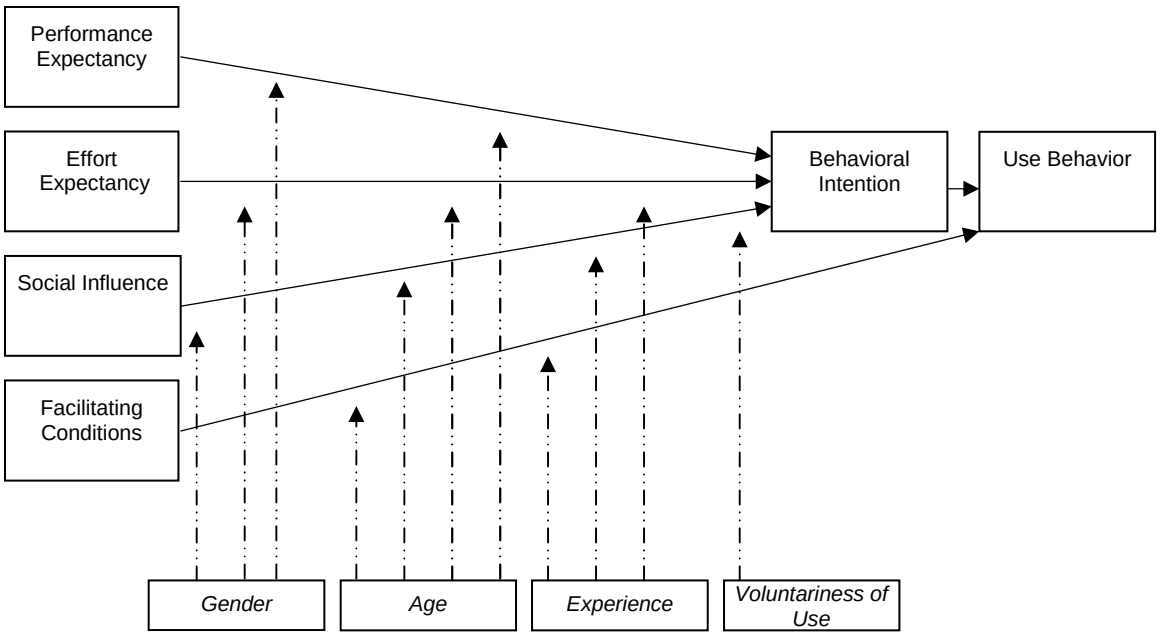

Figure 3.2. UTAUT IT Acceptance Model. *Source:* Venkatesh, et al., "User Acceptance of Information Technology," 447.

The Performance model comprises one dichotomous predictor and one outcome variable. This model was used to determine the effectiveness of two learning delivery modes – Face to Face (FTF) and Mobile Learning (M-Learning).

The UTAUT model comprises four predictor, two outcome, and four moderator variables. This model was used to determine use and acceptance of the M-Learning information system

3.2 Research Approach

The study employed a quasi-experimental, pretest, posttest design comprising two groups of participants: Control (FTF) and Treatment (M-Learning). An overview of the study design is presented in figure 3.3.

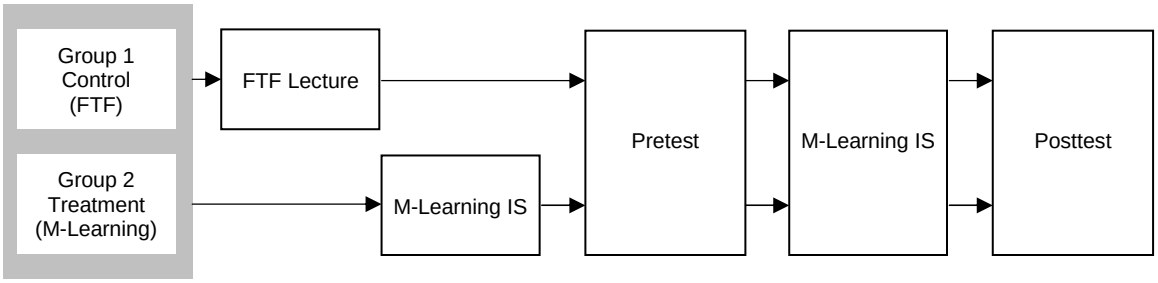

Figure 3.3: Study design overview. *Source*: Investigator.

The study design is consistent with that described by Cook and Campbell, and Campbell and Stanley's quasi-experimental research into various experimental design methodologies.[199]

The quasi-experimental design is:

> One of the most widespread experimental designs in educational research . . . [it] involves an experimental group and a control group both given a pretest and a posttest, but in which the control group and the experimental group do not have pre-experimental sampling equivalence. Rather, the groups constitute naturally assembled collectives such as classrooms, as similar as availability permits but yet not so similar that one can dispense with the pretest. The assignment of X to one group or the other is assumed to be random and under the investigator's control.[200]

199. "Experiments that have treatments, outcome measures, and experimental units, but do not use random assignment to create the comparisons from which treatment-caused change is inferred. Instead, the comparisons depend on nonequivalent groups that differ from each other in man ways other than the presence of a treatment whose effects are being tested." – Thomas D. Cook, Donald T. Campbell, *Quasi-Experimentation: Design & Analysis issues for Field Settings* (Boston: Houghton Mifflin, 1979), 6;Donald T. Campbell and Julian C. Stanley, *Experimental and Quasi-Experimental Designs for Research*, (Denver, CO; Houghton Mifflin, 1963), 34

200. Campbell and Stanley, Experimental and Quasi-Experimental Designs, 47.

The study included three time (T) contact points:

1. Time 1 (T1): Computer laboratory session 1
2. Time 2 (T2): Computer laboratory session 2
3. Time 3 (T3): Computer laboratory session 3

180 students out of a total of 266 eligible students across seven sections of an undergraduate Introduction to Information Systems course participated in the study – a 68% participation rate. 107 of the 180 participants completed all requirements across the three contact times – 60% of participants; 40% of eligible students.

Two incentives to participate were provided: 1) one U.S. $100 Apple Store gift certificate per section was awarded to the student with the highest average grade across both quizzes, and 2) extra credit applied to a participants' final course grade was awarded at the discretion of section FTF lecturers based on a student's average grade across both quizzes.

Each section of approximately 40 students regularly attended one lecture and one computer laboratory (lab) session per week over the course of a 15-week semester (see table 3.1).

Table 3.1. Sample Schedule for One Course Section.

Week	Session Type
1	FTF Lecture
1	Lab
2	FTF Lecture
2	Lab
3 – 15	FTF Lecture
3 – 15	Lab

Source: Investigator.

The close occurrence of lecture and lab sessions provided a scenario where a longitudinal study could be conducted. Potential external validity issues were mitigated due to the relatively short (one week) duration between periods T1→T2, and T2→T3; the study was conducted over a two-week period.

A course section was split into two lab sessions because a typical lecture room could hold ~40 students while a typical lab room could seat only ~20 students. All but one of the lab sessions for a given section were conducted at the same time and on the same day, albeit different from the lecture day. The anomalous lab was conducted at two different times on the same day.

FTF lectures were conducted by full-time or adjunct faculty members. Labs were conducted by a mixture of adjunct faculty members and graduate teaching assistants. In all but one case, a given section's lab sessions were taught by an instructor different from that of the courses' FTF instructor.

For the study, both simultaneously occurring labs sessions from a single FTF section were combined into one and randomly assigned as a Control (FTF) or Treatment (M-Learning) group. Each Control and Treatment group was the equivalent of a course section, comprised of two lab sessions. The seven course sections provided six Control and six Treatment groups. The seventh section comprised labs that were conducted at different times on the same day. These participants were randomly assigned as a Treatment group. (see figure 3.4).

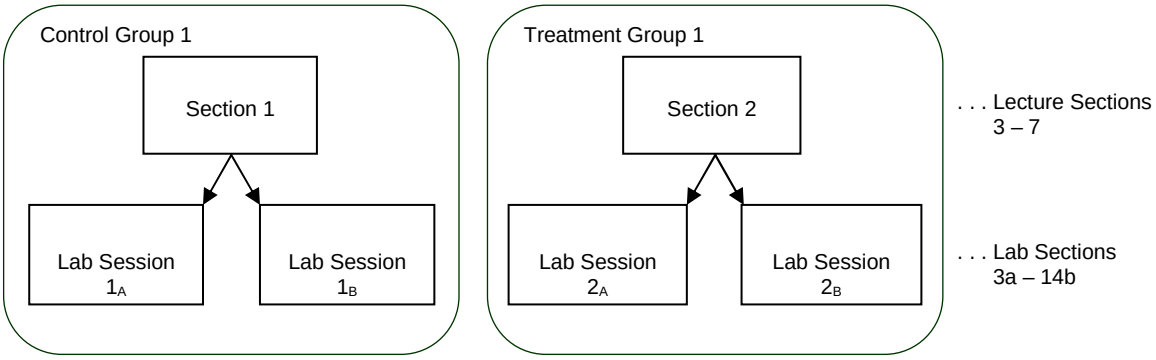

Figure 3.4. Introduction to Information Systems Section Lecture/Lab Configuration. *Source:* Investigator.

Enrollments for each section are shown in table 3.2.

Table 3.2. Study Section Enrollments

Section	Lab	Lab Enrollment	Total
1	1_A	18	
	1_B	18	
			36
2	2_A	18	
	2_B	18	
			36
3	3_A	16	
	3_B	14	
			30
4	4_A	18	
	4_B	18	
			36
5	5_A	19	
	5_B	18	
			37
6	6_A	18	
	6_B	18	
			36
7	7_A	19	
	7_B	18	
			37
			266

Source: Investigator.

A quasi-experimental approach was taken based on the following study elements:

1. Comparison of M-Learning to FTF

   FTF predates D-Learning, E-Learning and M-Learning. As the oldest and most widely used teaching platform FTF is arguably the preeminent form of education delivery. It is appropriate to evaluate the effectiveness of the M-Learning alternate mode of education delivery against FTF.

2. Data Warehousing

   Each lecture section instructor provided an overview of the basic principles of Data Warehousing prior to the study. The study complemented this lecture with instruction on intermediate and advanced principles of Data Warehousing. This topic was favored because it complimented and added value to students' pre-existing knowledge of Data Warehousing.

3. Testing

   Over the course of their academic careers, undergraduates have become familiar with the process of performance measurement through testing. As such, a two quiz study design presented a familiar environment to students.

4. UTAUT

   It is important to understand the factors that influence the performance of students using M-Learning. The study focused on user acceptance and use. This study did not 'pick and choose' from the plethora of available IT acceptance methodologies to determine IT acceptance as Venkatesh, et al. observed in other studies. Rather, the UTAUT model was employed in the

study because it represented a ‘best of breed’ approach; the model is an aggregate of eight of the most accepted, popular, and effective user acceptance methodologies.

5. Online Course Management Tool

   Providing access to an MP3 recording of the FTF lecture required electronic intervention. Each study participant needed to be provided with access to the audio file. Students regularly used, and were familiar with Blackboard – the course management system used to host the MP3 recording. This eliminated the need to develop a specialized IS to distribute digital content.

6. Educational Environment

   A quasi-experimental design using students in lab rooms provided controlled environments. At T1, labs provided a natural setting for the delivery of a FTF lecture to the Control group. Each lab could be closed off to provide privacy and minimize external distractions.

The first treatment occurred at T1 when an FTF lecture on Data Warehousing was delivered to each Control group. Each lecture was recorded and converted to an MP3 recording. Between T1 and T2 the MP3 recording *was* made available to a Control group’s paired Treatment group . . . between T1 and T2 the MP3 recording *was not* made available to Control (FTF) groups. A Control/Treatment group pair received a unique combination of FTF lecture and MP3 file (see figure 3.5).

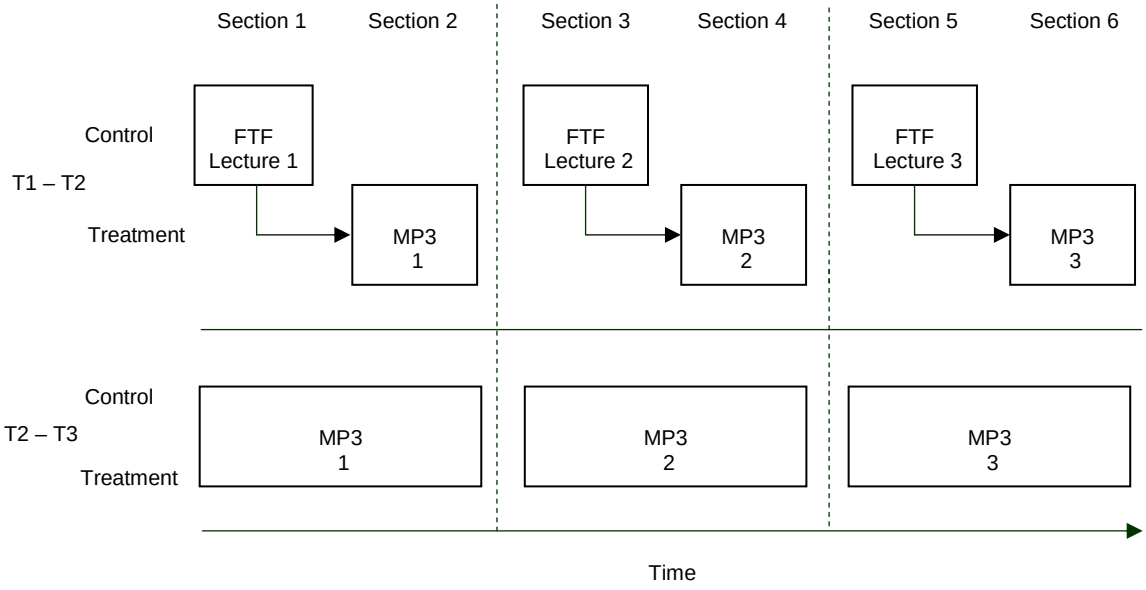

Figure 3.5. *Above,* FTF/MP3 Administration T1 – T2; *below*, FTF/MP3 Administration T2 – T3. *Source:* Investigator.

At T2 Quiz 1 was administered to the study population. Between T2 and T3 *all* participants were provided with access to the MP3 recordings of their paired FTF lecture Control group. At T3 Quiz 2, a demographic questionnaire, and UTAUT survey was administered. Each participant's M-Learning MOD Use Log, a self-report instrument used to capture when and where (if at all) each participant listened to the MP3 file, was gathered (see appendix 3).

3.3 Incorporation of Perform and Mode of Delivery

3.3.1 Perform

The theoretical grounding and hypotheses formation for this research is derived from the Performance and UTAUT models. A previous study that used the TAM user

acceptance model to measure the acceptance of an E-Collaboration System is used as justification to include student performance as a measure of system effectiveness and acceptance (see figure 3.6). [201]

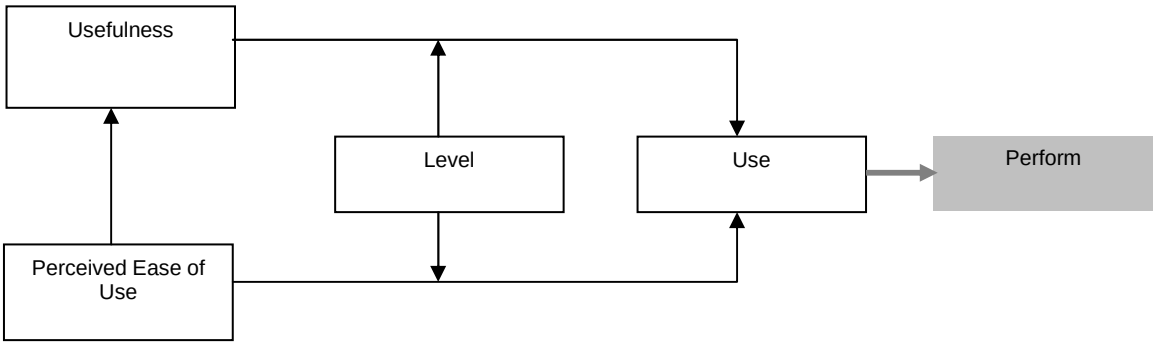

Figure 3.6. Dasgupta, et al., Research Model – Perform Added (Revised TAM Model). *Source:* Dasgupta, Granger and McGarry, "User Acceptance", 92.

Dasgupta, et al. posit that the TAM Use construct naturally leads to a measure of ". . . performance of users of the system."[202] Perform variable calculation is done through a ". . . weighted average of scores in assignments, exams, and projects."[203] Included in their hypotheses was an analysis of System Use on Individual Performance:

H5: *Use of the system has a positive effect on Individual Performance*

Significant positive effect

In this study the performance of participants on Quiz 1 was used to determine whether M-Learning was more effective than FTF (see figure 3.7). Weighted averages were not used – a possible limitation of this study. This presents a limitation because

201. Subhasish Dasgupta, Mary Granger, and Nina McGarry, "User Acceptance of E-Collaboration Technology: An Extension of the Technology Acceptance Model," *Group Decision and Negotiation* 11, (2002): 92.

202. Ibid.

203. Ibid.

Dasgupta, et al.'s study procedures were adopted in order to justify the incorporation of Perform into the adapted UTAUT model, but the weighted average procedure was not followed.

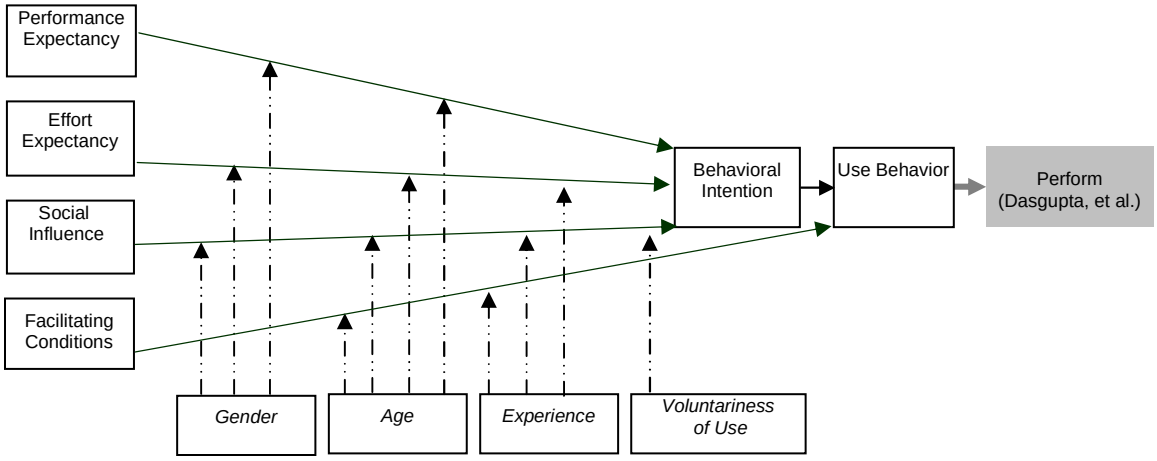

Figure 3.7. Modified UTAUT Model**.** *Sources:* Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 447; Dasgupta, Granger, and McGarry, "User Acceptance of E-Collaboration Technology," 87-100.

Quiz 1, Quiz 2, the UTAUT survey instrument, demographics questionnaire, and the M-Learning MOD Use Log were used to measure M-Learning acceptance and use.

3.3.2 Mode of Delivery

The dichotomous predictor variable Mode of Delivery (MoD) appears in the Performance model in order to investigate the effects of FTF and M-Learning on performance. This research also incorporates MOD into UTAUT. With the introduction of any variable to a model, consideration must be given to its role and placement. Mode of Delivery can be incorporated as one of three variable types:

1. Predictor variable (PV)
2. Outcome variable (OV)
3. Moderating variable (MV)

3.3.2.1 Mode of Delivery as a PV: Model 1a

In Model 1a (see figure 3.8) MOD is cast as a PV preceding the original UTAUT model PVs. This presents a favorable condition whereby it is possible to measure the impact of Mode of Delivery on the entire UTAUT model. However, it is impossible to measure the impact of UTAUT PVs and MVs on MOD.

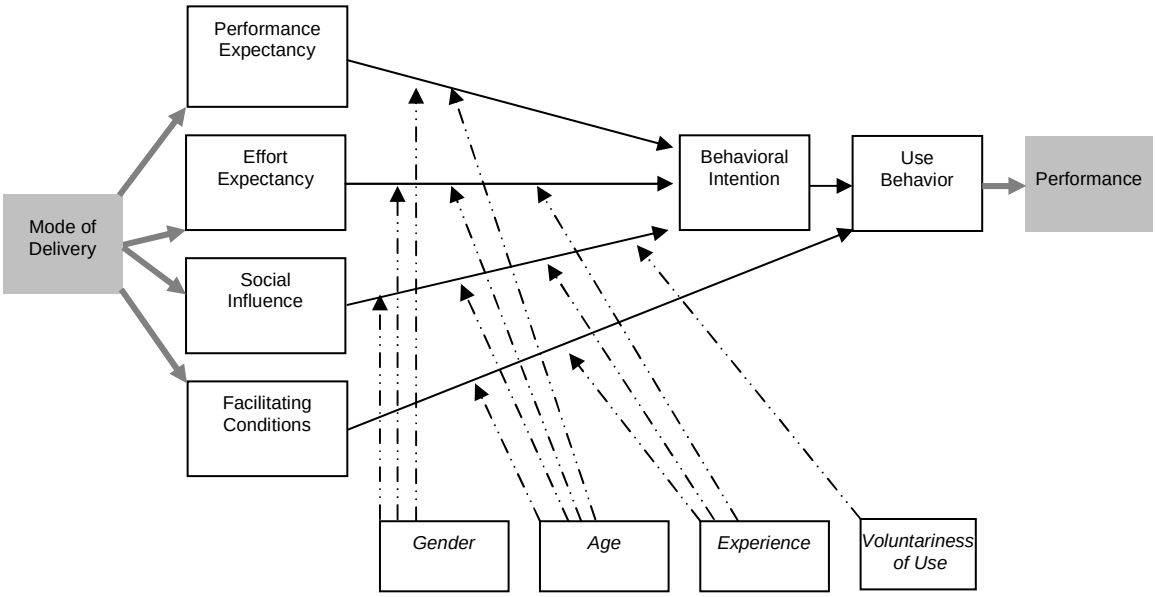

Figure 3.8. Modified UTAUT Model 1a: Mode of Delivery as a PV prior to UTAUT. *Source:* Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 447.

3.3.2.2 Mode of Delivery as a PV: Model 1b

In model 1b (see figure 3.9), MOD is again cast as a PV, albeit placed alongside, rather than prior to, UTAUT PVs. The impact of all UTAUT MVs on MOD can be measured. The impact of PVs on MOD cannot be measured.

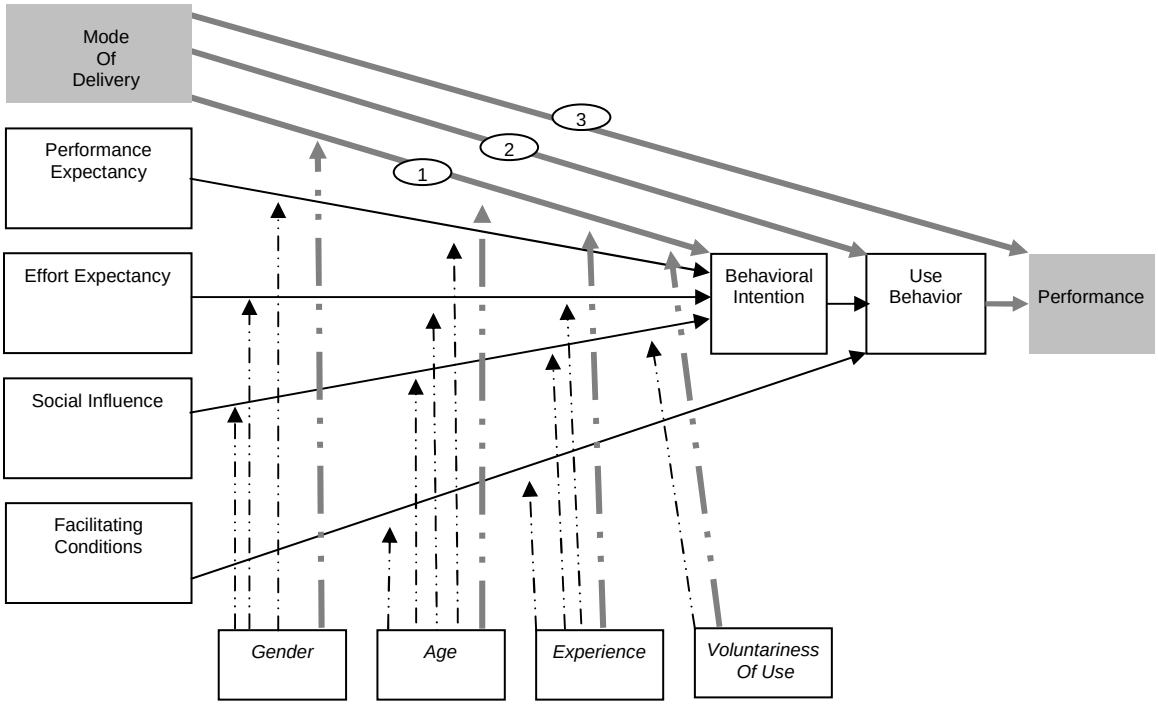

Figure 3.9. Modified UTAUT Model 1b: Mode of Delivery as a PV within UTAUT. *Source:* Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 447.

3.3.2.3 Mode of Delivery as an MV

UTAUT MVs represent demographic measures, i.e. Gender, Age, Experience, and Voluntariness of Use. While MOD is not a demographic measure, cast as an MV its presence can affect the ". . . direction and/or strength of the relation between an

independent or predictor variable and a dependent or criterion [outcome] variable"[204] (see figure 3.10).

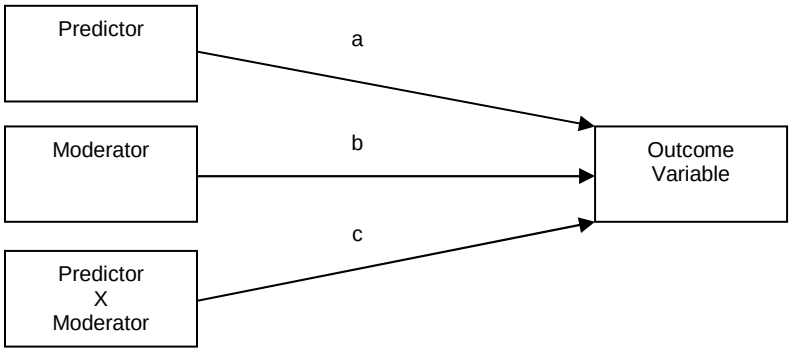

Figure 3.10. Moderator Model. *Source:* Baron and Kenny, "The Moderator-Mediator Variable Distinction," 1174.

Baron and Kenny explain that, "The moderator hypothesis is supported if the interaction (Path *c*) is significant. There may also be significant main effects for the predictor and moderation (Paths *a* and *b*) but these are not directly relevant conceptually to testing the moderator hypothesis." [205]

In this study, MOD is cast as an MV. This provides an opportunity to evaluate and hypothesize the impact of Mode of Delivery similar to the way in which Venkatesh, et al. hypothesized the original UTAUT MVs. Additionally, and consistent with Dasgupta, et al., Mode of Delivery can be hypothesized as a potential MV in the relationship between Use Behavior and Performance. The placement of Mode of Delivery in the study model is shown in figure 3.11.

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204. Reuben M. Baron and David A. Kenny, "The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations," *Journal of Personality and Social Psychology* 51, no. 6 (1986): 1174.

205. Ibid.

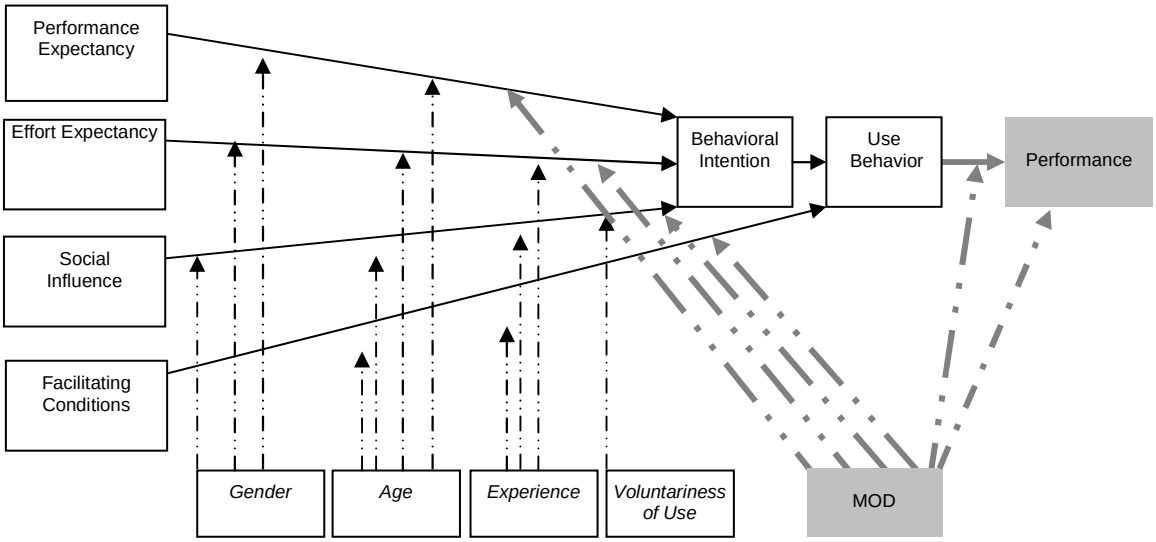

Figure 3.11. Modified UTAUT Model 2: Mode of Delivery as a Moderator. *Source:* Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 447.

3.4 The No Significant Difference Phenomenon

In his text *The No Significant Difference Phenomenon*[206], Russell compiles 355 studies, technical reports, and dissertations from 1928 that have:

> . . . reviewed student learning outcomes in the form of satisfaction surveys, grade comparisons, standardized test scores, common embedded questions, frequency of interaction between students and faculty, and a dizzying array of other "measures" ostensibly aimed at determining if any measurable or statistically significant differences exist.[207]

Russell found no significant difference (NSD) in performance between alternate modes of education. He attributes subsequent findings where a significant difference (SD) *was* noted to content designed and/or optimized for the specific media and

206. Russell, *The No Significant Difference Phenomenon*.

207. Thomas R. Ramage, "The 'No Significant Difference' Phenomenon: A Literature Review," Unpublished Manuscript, http://www.usq.edu.au/electpub/e-jist/docs/html2002/ramage.html (accessed February 3, 2008).

demographic/learning attributes of course participants.

In this study the choice of a hosted MP3 file as M-Learning media *was not* made with consideration of design and/or optimization of learning objects for specific media and demographic/learning attributes of course participants. Rather, the use of MP3 media in the study was based on factors including:

1. Ease of use of audio files
2. Ubiquity of audio playback information appliances
3. Participants' familiarity with the MP3 audio format
4. Participants' familiarity with the Blackboard content hosting platform

Based on Russell's observations and because this study *did not* use content designed and/or optimized for specific media and demographic/learning of course participants, one might assert that, à priori, this study would find NSD between FTF and the M-Learning alternate mode of education.

Against this background, however, the results of this study *were not* a foregone conclusion. The study was a plausible, generalizable, and significant contribution to the Information Systems and education literature because M-Learning was born, evolved, and began to mature *after* Russell's landmark tome was published. Therefore, the results of a study designed to capture the acceptance, use, and performance of an alternate education paradigm conceived after Russell's publication vis-à-vis FTF remained an unknown.

Although content design and/or optimization of the specific media chosen for this study did not take into consideration the peculiar demographic or learning characteristics

of participants, the study nonetheless adopted common methods deployed by hundreds of precedent-creating schools.[208] These schools had, since Russell's research, uploaded verbatim M-Learning audio file versions of FTF lectures to the Web for subsequent download to mobile information appliances.

The resounding popularity of M-Learning, dearth of studies surrounding the use and acceptance of the alternate delivery method, and significant lack of media comparison studies (MCS) comparing the performance of M-Learning students to FTF students, revealed a gap in the literature which the study aimed to fill. In summary, there was no reason to believe that a finding of NSD was a foregone conclusion simply because M-Learning was a means of education delivery different than FTF.

As an example of schools that upload course content for student playback without regard to learning styles and instructional design considerations, the following anecdotal evidence is provided; beginning in fall of 2004, Duke, Brown, Stanford, the University of Michigan, the Missouri School of Journalism and the University of Wisconsin-Madison worked directly with Apple Computer in a pilot study to test iTunes U.[209] Shortly after the pilot began, Richard Lucic, Duke Associate Chair of the Department of Computer Science stated, "There are a lot of ways we could distribute content, but iTunes U is just a

208. Apple Computer Corporation, "iTunes U: The Campus that Never Sleeps," under "Join the Movement".

209. David Menzies, "iTunes U Making Impact at Duke," http://www.dukenews.duke.edu/2006/02/iTunes%20U.html (accessed February 3, 2008)

very convenient way to share the information students create and I create. It gives students an easy way to login and upload their content."[210]

The schools did not upload content with consideration for instructional design methodologies. Verbatim audio recordings of FTF lectures were uploaded in lieu of more complex, multimedia-rich, and 'cognitively correct' methodologies because the former was relatively simple and convenient to do so by students and faculty alike. Duke was so impressed with the iTunes U technology that they distributed 1,750 iPods during the 2005-2006 academic years.[211]

Other anecdotal evidence of the flexibility of multimedia files includes Stanford's iTunes U homepage which states, "Download courses, faculty lectures, interviews, music, and sports".[212] The popularity of iTunes U and the sheer volume of classroom audio content available on the site is evidence that, regardless of significant findings or not, strategies for hosting recordings of FTF material on the Web are popular.

If one considers the number of schools both in the pilot and production iTunes U phase – more than half of the nation's top 500 post-secondary schools currently subscribe to the service[213] – then popularity and frequency of use would seem to indicate that

210. Ibid.

211. Ibid.

212. Stanford on iTunes U, "Stanford on the Go," http://itunes.stanford.edu/ (accessed February 3, 2008).

213. Apple Computer Corporation, "iTunes U: The Campus that Never Sleeps," under "Join the Movement".

audio-only versions of FTF content in an M-Learning environment are effective – of significant difference.

Russell says that alternate education strategies that *do* employ specific media design, etc. will be more likely to be of SD, yet Russell does not predict that M-Learning strategies that *do not* employ alternate education strategies employing specific media design, etc. will be found to be of NSD. In summary, the outcomes of MCS employing specific media designs are fuzzy at best, especially in the face of such new education delivery modes as M-Learning.

More recently than Russell's research, in October 2007, Jeff Seaman, survey director for the Sloan Consortium states:

> If you ask the people who do have online experience over a number of years, they tell us the quality of online and face-to-face learning is equivalent," . . . "They don't worry about the reputation of the degree. They think (e-learning) is perfectly viable and that it's serving its audience well. It doesn't mean it's without problems, but it is working. And over the past five years, they've grown more positive in that regard.[214]

Seaman provides a current assessment of alternate education delivery that alludes to SD; the picture remains unclear – are or are not alternate education delivery modes more effective that FTF?

Confounding the issue is today's post-secondary schools' students' familiarity with audio playback technologies and information appliances in general. This 'digital native'[215] population is savvy, has grown along with the maturation of digital audio

214. Summerfield, "One out of Five Higher Ed Students Takes Online Courses".

215. Marc Prensky, "Digital Natives, Digital Immigrants," *On the Horizon* 9, no. 5 (2001): 1-6.

technology, and has witnessed and participated in the evolution of electronic technologies designed to distribute multimedia content.

The Digital Native population is comfortable with, and capable of, connecting wirelessly to the Web and manipulating audio files on iPods and smart appliances:

> Today's students have not just changed *incrementally* from those of the past, nor simply changed their slang, clothes, body adornments, or styles, as has happened between generations previously. A really big *discontinuity* has taken place. One might even call it a "singularity" – an event which changes things so fundamentally that there is absolutely no going back. This so-called "singularity" is the arrival and rapid dissemination of digital technology in the last decades of the 20th century.
>
> Today's students – K through college – represent the first generations to grow up with this new technology. They have spent their entire lives surrounded by and using computers, videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age. Today's average college grads have spent less than 5,000 hours of their lives reading, but over 10,000 hours playing video games (not to mention 20,000 hours watching TV). Computer games, email, the Internet, cell phones and instant messaging are integral parts of their lives.[216]

3.5 Hypothesis Formation

> It seems that someone always wants to know if technology "makes a difference." Sometimes it is a legislator, hoping that technology will reduce costs. Sometimes it is the college or university president, hoping for a competitive edge. Sometimes it is the provost, hoping to prove that students learn more in online courses than in face-to-face settings. Sometimes it is a faculty member, hoping to show just the opposite. One group will claim that using technology produces no significant difference; another will say that technology has transformed higher education.
>
> – Diane Oblinger and Brian Hawkins, *IT Myths: The Myth about No Significant Difference*[217]

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216. Ibid.

217. Diane G. Oblinger and Brian L. Hawkins, "IT Myths: The Myth about No Significant Difference," *EDUCAUSE*, (November/December 2006) http://www.educause.edu/ir/library/pdf/erm0667.pdf (accessed February 3, 2008).

This study adopted UTAUT hypotheses because the model favored a belief that familiar, easy-to-use technologies would drive increased use behavior which would consequently equate to increased performance.

Not adopted in the study were UTAUT hypotheses regarding age although Venkatesh, et al. find through their research that age plays an important part in Use Behavior. The investigator felt à priori that the age of participants in the sophomore Introduction to Information Systems course would be too similar for hypotheses regarding age of participants to have significant effect.

Venkatesh, et al. conduct their research in work settings in the private sector. These settings provided study participants whose ages varied widely (see table 3.3).

Table 3.3. Description of UTAUT Studies

Study	Industry	Functional Area	Sample Size	System Description
Voluntary Use				
1a	Entertainment	Product Development	54	Online meeting manager that could be used to conduct Web-enabled video or audio conferences in lieu of face-to-face or traditional phone conferences
1b	Telecommunications Services	Sales	65	Database application that could be used to access industry standards for particular products in lieu of other resources (e.g., technical manuals, Web sites)
Mandatory Use				
2a	Banking	Business Account Management	58	Portfolio analyzer that analysts were required to use in evaluating existing and potential accounts
2b	Public Administration	Accounting	38	Proprietary accounting systems on a PC platform that accountants were required to use for organizational bookkeeping.

Source: Venkatesh, et al. "User Acceptance of Information Technology," 438.

Because Mode of Delivery (MOD) was added as an MV, additional hypotheses were defined that captured the effect of MOD on Behavioral Intention and Performance.

3.5.1 UTAUT Included/Excluded Variables

As a result of their investigations into the eight underlying models of UTAUT, Venkatesh, et al. state that "[s]even constructs [appear] to be significant direct determinants of intention or usage in one or more of the individual [underlying UTAUT] models":[218]

1. Anxiety
2. Attitude toward using technology
3. Effort Expectancy
4. Facilitating Conditions
5. Performance Expectancy
6. Self efficacy
7. Social Influence

Further investigations by Venkatesh, et al. lead them to conclude that the constructs Attitude Toward Using Technology, Self Efficacy, and Anxiety are *not* direct determinants of [Behavioral Intention].[219] They exclude these constructs from consideration both in the UTAUT model and survey instrument. Hypotheses in this study include those from: 1) the modified UTAUT model, and 2) the Performance Model.

218. Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 440 – 441.

219. Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 447.

3.5.2 Hypotheses

In order to evaluate the UTAUT model in an M-Learning environment, the study adapted six hypotheses introduced by Venkatesh, et al. Additional hypotheses were incorporated into the study in order to examine the effects of Mode of Delivery on the modified UTAUT model.[220] A list of study hypotheses is included in table 3.4.

Table 3.4. Study Hypotheses

Hypothesis	Description
H1a	The effect of Performance Expectancy on Behavioral Intention will be moderated by Gender such that the effect will be stronger for men.
H1b	The effect of Performance Expectancy on Behavioral Intention will be moderated by Mode of Delivery.
H2a	The effect of Effort Expectancy on Behavioral Intention will be moderated by Gender and Experience such that the effect will be stronger for women and particularly at early stages of exposure to the M-Learning MOD.
H2b	The effect of Effort Expectancy on Behavioral Intention will be moderated by Mode of Delivery.
H3a	The effect of Social Influence on Behavioral Intention will be moderated by Gender, Experience, and Voluntariness such that the effect will be stronger for women particularly in mandatory settings in the early stages of Experience with the M-Learning MOD.
H3b	The effect of Social Influence on Behavioral Intention will be moderated by Mode of Delivery.
H4a	The effect of Facilitating Conditions will not have a significant influence on Behavioral Intention.

220. Venkatesh, et al., "User Acceptance of Information Technology," 450-456. Adapted from Russell, *The No Significant Difference Phenomenon*; Adapted from R. Clark, "Media Will Never Influence Learning," *Educational Technology Research and Development* 42, no. 2 (1994): 21-29; Adapted from A. Tait, "Students and Attachment: The Nature of Electronic Relationships," *Adult Learning* 11, no. 10 (2000): 20-22; Investigator.

Hypothesis	Description
H4b	The effect of Facilitating Conditions on M-Learning System Use Behavior will be moderated by Experience with the M-Learning MOD such that the effect will be stronger for students with increasing Experience.
H4c	The effect of Facilitating Conditions on M-Learning MOD Use Behavior will be moderated by Mode of Delivery.
H5	The effect of Behavioral Intention on M-Learning MOD Use Behavior will be moderated by Gender.
H6a	Mode of Delivery will have an influence on Quiz 1 Performance.
H6b	Mode of delivery will have an influence on Quiz 2 Performance.
H6c	The effect of Use Behavior between Time 2 and Time 3 on Quiz 2 Performance will be moderated by Mode of Delivery.
H6d	The effect of Use Behavior between T1 and T3 on Average Performance over Quiz 1 and Quiz 2 will be moderated by Mode of Delivery.
H6e	The effect of Use Behavior on the difference between Performance on Quiz 1 and Quiz 2 will be moderated by Mode of Delivery.

Source: Investigator.

3.6 Research Design

The quasi-experimental design selected for this research is the Nonequivalent Control Group Design (see figure 3.12).

O	X	O
O		O

Figure 3.12. Nonequivalent Control Group Design. *Source:* Donald T. Campbell and Julian C. Stanley, *Experimental and Quasi-Experimental Designs for Research* (Dallas, TX: Houghton Mifflin, 1963): 47-50.

Three of seven Introduction to Information Systems course sections that participated in the study were randomly assigned as Control groups; three sections were assigned as Treatment groups. The remaining section was randomly assigned to a Treatment group. Control and Treatment sections were randomly paired.

The investigator had no control over pre-study sampling equivalence prior to T1. The breadth and depth of instruction on Data Warehousing topics delivered in the classroom environment was at the FTF instructor's discretion. Additionally, students may have been introduced to the principles of data warehousing prior to the Introduction to Information Systems course. Therefore, ascertaining participating students' levels of pre-existing knowledge of Data Warehousing was impossible.

The only true equivalence in pre-study experience was the use of a common textbook across sections. The FTF lecture administered at T1 was ideal because it provided an equivalent level of Data Warehousing exposure for each participant prior to taking Quiz 1.

3.6.1 Variable Operationalization

Five core determinants of acceptance, use, and performance were used in this research design; each is operationalized here.[221] The core determinants are Mode of Delivery, Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions.

Each UTAUT variable was operationalized as an aggregate of constructs utilized in the eight models underlying UTAUT:

1. Combined TAM and TPB (C-TAM-TPB)
2. Innovation Diffusion Theory (IDT)

221. James Dean Brown, "Research Methods for Applied Linguistics: Scope, Characteristics, and Standards." In *The Handbook of Applied Linguistics*, ed. Alan Davies and Catherine Elder, (Malden, MA: Blackwell, 2006), 476-501. "In variable operationalization research, the researcher clearly outlines the variables of interest . . . (particularly the dependant, independent, and moderator variables) and explains how each one was operationalized, that is, how each one was observed or measured and quantified."

3. Model of PC Utilization (MPCU)
4. Motivational Model (MM)
5. Technology Acceptance Model (TAM)
6. Theory of Planned Behavior (TPB)
7. Theory of Reasoned Action (TRA)
8. Social Cognitive Theory (SCT)

This study added Performance as an outcome variable (OV) to the UTAUT model. Performance is a continuous variable whose values can take on the values zero through 100 representing a participant's score on Quiz 1 and Quiz 2. The study added the dichotomous moderator variable (MV) Mode of Delivery (MoD) to the UTAUT model. It was also incorporated into the Performance model to differentiate between the M-Learning and FTF modes of delivery.

Use Behavior was measured through each participant's M-Learning MOD Use Log. Although participant MP3 download behavior could have been gleaned from Blackboard, self reporting M-Learning MOD use was preferred because the MP3 could be downloaded from Blackboard once and listened to several times on a playback device. Alternately, a participant could have copied the file from another participant. A participant might also download the file and never listen to it. Neither situation provided a means to accurately track Use Behavior; therefore download activity could not be used as a proxy for actual usage.

3.6.2 Information Systems Context

The IS context developed for this study's M-Learning IS MOD was based on four criteria, the whole of which were intended to replicate the application of real-world FTF and M-Learning lectures. Items three and four were exceptions to the generalization of the study:

1. Performance on Quiz 1 was a product of T1 – T2 activities:
    a. Notes and recall of content delivered at T1 during the FTF lecture
    b. Notes and recall of MP3 content
2. Similarly, performance on Quiz 2 was a function of FTF and MP3 learning delivery methodologies, albeit over the entirety of the study duration; T1 through T3
3. Performance results on Quiz 1 and Quiz 2 were not provided to participants until all participants had completed both Quizzes
4. Quiz 2 was identical to Quiz 1 (questions and possible answers were, however, randomly scrambled)

3.6.3 Subject Selection

The target population for the study was undergraduate business students attending a mandatory Introduction to Information Systems course. Several factors influenced this particular choice of subjects for research purposes:

1. A common understanding of testing helped to create a relatively homogeneous set of expectations.
2. The use of a weekly computer lab was standard across sections. This structure afforded an opportunity for the investigator to work with participants across sections during a regularly scheduled lab without impacting stated learning objectives.

3. The course was mandatory – this provided a large pool from which to sample (266 students).

4. The study was scheduled to take place during regularly scheduled labs and was purely optional; the problem of self-selection of only highly motivated students was avoided.

5. Participating students represented a homogeneous population: similar ages, school year, and demographic diversity representative of the university undergraduate population as a whole.

3.6.4 Instrumentation

The study comprised:

1. A verbal study introduction (see section 3.6.4.1)

2. A written, IRB approved study overview distributed to students (see section 3.6.4.1)

3. A pseudonym assignment document (see section 3.6.4.2)

4. An FTF lecture (see section 3.6.4.3).

5. Three MP3 recordings of FTF lectures (see attachment 1).

6. An M-Learning MOD Use Log (see appendix 3)

7. Quiz 1 administered to Control and Treatment groups at T2 (see section 3.6.4.5)

8. MP3 File access granted to a paired Control and Treatment group over T2 through T3 (see section 3.6.4.7)

9. A Demographics questionnaire administered to Control and Treatment groups at T2 (see section 3.6.4.4)

10. Quiz 2 administered to Control and Treatment groups at T3 (see section 3.6.4.5).

11. A UTAUT survey administered to both Control and Treatment groups at T3 (see section 3.6.4.6)

3.6.4.1 Introduction of the Study

The Investigator delivered a verbal introduction and overview of the study to all students in each participating lab. To ensure parity of study introductions across labs, a document comprising key concepts to be covered was assembled (see appendix 4). After discussing the overview with lab students, each was asked whether they would like to participate. Those students who indicated a willingness to participate received a copy of the Institutional Review Board (IRB)-approved Study Overview document (see appendix 5) and pseudonym assignment document (see appendix 6, section 3.6.4.2).

3.6.4.2 Confidentiality and Anonymity

Each two-page pseudonym assignment document (see appendix 6) contained a unique, randomly generated alphanumeric identifier (pseudonym). The first page of the document included the pseudonym and a warning to participants not to misplace it. Participants were informed that if the unique identifier *was* misplaced, study administrators might not be able to retrieve it. Because the identifier was required to be placed on each study instrument, loss of the code would prohibit a participant from further engaging in study procedures.

The second page of the document included the pseudonym and space for participants to write their first and last name. Participants returned this page to the lecture instructor. The page was then copied; one copy was returned to the lab instructor, the other to the Primary Investigator for archiving (see section 3.8). At no time did the Investigator have access to personalized pseudonym.

Investigator knowledge of depersonalized pseudonyms was necessary in order for quiz grades to be matched to the appropriate participant. For example, after grading quizzes, the Investigator returned a master sheet of pseudonyms and matched grades to lecturers in order for extra credit points to be calculated and assigned to the appropriate participants.

Participants were eligible for extra credit only if they completed *all* study assignments and instruments (quizzes, questionnaire, survey, M-Learning MOD Use Log, etc.). The pseudonym was used by the Investigator to match these instruments across the duration of the study.

When not in use, pseudonyms and other study instruments were protected as per procedures discussed in section 3.8).

3.6.4.3 FTF/MP3 Lecture

A FTF lecture comprising intermediate Data Warehousing subject matter was delivered to each Control group (see appendix 7). Lecture content was based on chapter 11 of Hoffer, et al.'s Modern Database Management textbook.[222] The data warehousing topic was selected because it was consistent with lecturers' learning outcomes, the investigator's familiarity with the subject, participants' database training in previous lab sessions, and the availability of a pre-validated quiz question bank from the textbook publisher.

222. Jeffrey A Hoffer, Mary B. Prescott, and Fred R. McFadden, *Modern Database Management*. 8th ed. (NJ: Pearson Prentice Hall, 2008).

Each FTF lecture was digitally recorded and converted to an MP3 file (see attachment 1). The MP3 file was posted to Blackboard and made exclusively available to a Control groups' paired Treatment group over T1 through T2. Over T2 through T3 the MP3 file was made available to both the Control and FTF group within a pair. Directions for downloading the MP3 file were distributed on paper (see appendix 8). The document was also posted on Blackboard.

Visual aids were not used during the FTF lecture in order to eliminate any advantage a FTF Control group had over its paired Treatment group, i.e. the Treatment group was only exposed to an audio recording of the lecture. No questions were permitted to be asked during the three FTF lectures in order to maintain as much parity as possible with Treatment groups.

The FTF lecture was created after vetting all available multiple-choice questions in the quiz bank. After the vetting process was complete, questions were assembled into a quiz (see section 3.6.4.5). The lecture was created through a 'reverse engineering' process whereby lecture content was derived from quiz questions. This process was performed in order to ensure that the lecture included an overview of all quiz questions.

The script was read verbatim by the investigator to each Control group with only slight variations based on time of day, energy level, rate of speech and other naturally occurring delivery anomalies. Each FTF lecture was delivered in the same room.

3.6.4.4 T2 – Demographics Questionnaire

A demographics questionnaire (see appendix 9) was administered at T2 prior to the distribution of Quiz 2. The questionnaire was designed to capture participant responses to the following questions:

1. Age
2. Class Standing
3. Field of Study – 4 Year Programs
4. Field of Study – 5 Year Programs
5. Gender
6. Race

Descriptive statistics and frequency tables summarizing participant responses to the questionnaire items can be found in section 4.2.1 and appendix 10, respectively.

3.6.4.5 Quizzes

Two timed (15 minutes long), 20-question, multiple-choice paper quizzes were administered; Quiz 1 at T2 (see appendix 11[223]) and Quiz 2 at T3 (see appendix 12[224]). Quiz questions were selected from a question bank provided by the publisher on a secure, password-protected website. The investigator received permission from the textbook publisher to access the test bank.

223. Adapted from Jeffrey A. Hoffer, Mary Prescott, and Fred McFadden, "TestGen 8/E," In Hoffer, Prescott, and McFadden, *Modern Database Management*, http://www.pearsonhighered.com/educator/academic/product/0,3110,0132212110,00.html (accessed February 28, 2008).

224. Ibid.

130 data warehousing questions were available from which to choose. Of these, 45 were multiple-choice questions. Only multiple-choice questions were considered for inclusion in the quizzes.[225]

Multiple-choice questions:

1. Can be effectively used to measure objectives ranging form simple memorization tasks to complex cognitive manipulations.

2. Since students' writing is minimized, a substantial amount of course material can be covered.

3. Scoring is relatively straightforward

4. With three to five options (1 correct answer, and the remaining distracters or foils), this instrument [can] reduce the potential for guessing.[226]

The 45 multiple-choice questions were vetted for substance, style, and audience appropriateness through a collaboration of the Investigator and two professors of Information Systems and Technology Management. The Investigator and faculty members had extensive experience teaching and evaluating database/data warehouse subject matter. A total of 20 questions were deemed appropriate for inclusion in the quizzes.

Quiz 2 differed from Quiz 1 in that Quiz 2 question order and answer choices were randomly scrambled. Quiz scrambling was automated using the textbook publisher's TestGen application (see figure 3.13).

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225. Barbara Gross Davis, *Tools for Teaching* (San Francisco: Jossey-Bass, 1993), 243. "Multiple-choice items can be used to measure both simple knowledge and complex concepts. Since multiple-choice questions can be answered quickly, you can assess students' mastery of many topics . . . [in] addition, the items can be easily and reliably scored."

226. Katia Passerini, "A Comparative Analysis of Performance and Behavioral Outcomes in Technology-Based Learning." (PhD diss., George Washington University, 2000), 213.

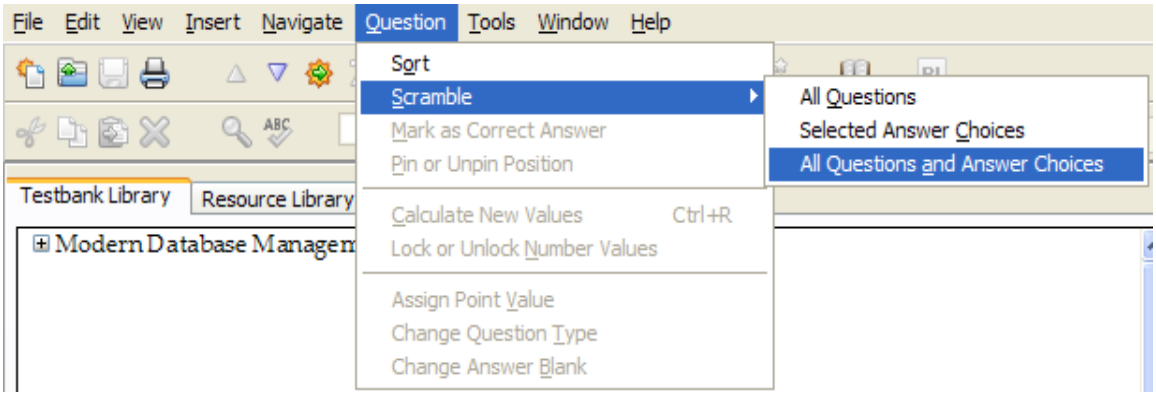

Figure 3.13. TestGen Scramble Option. *Source:* TestGen, a Pearson, Prentice-Hall Instructor Resource.

Grades for Quiz 1 were calculated as a ratio of correct: wrong answers, e.g. 10 correct answers equated to a grade of 50%; 15 correct answers were recorded as a grade of 75%. Grades for Quiz 2 were similarly calculated. A participants' average grade across both scores was calculated by summing the total number of correct answers on both quizzes and dividing by 40.

3.6.4.6 T3 – UTAUT Survey

The UTAUT survey is validated over time by Venkatesh, et al. in four implementations administered to working professionals in the private sector (see table 3.5).

Table 3.5. Description of UTAUT Studies

Study	Industry	Functional Area	Sample Size	System Description
Voluntary Use				
1a	Entertainment	Product Development	54	Online meeting manager that could be used to conduct Web-enabled video or audio conferences in lieu of face-to-face or traditional phone conferences
1b	Telecomm Services	Sales	65	Database application that could be used to access industry standards for particular products in lieu of other resources (e.g., technical manuals, Web sites)
Mandatory Use				
2a	Banking	Business Account Management	58	Portfolio analyzer that analysts were required to use in evaluating existing and potential accounts
2b	Public Administration	Accounting	38	Proprietary accounting systems on a PC platform that accountants were required to use for organizational bookkeeping.

Source: Venkatesh, et al. "User Acceptance of Information Technology," 438.

Appendix 13 reflects Venkatesh, et al.'s UTAUT survey items in addition to verbiage modifications applied to reflect the peculiarities of this study. The modifications were made in order to reflect: 1) appropriate tense to indicate post-study survey administration, 2) IS context, and 3) vocation, i.e. students versus working professionals.

A sample vocational and IS context survey item modification appears below:

- (original) 'I would find the ***system*** useful in my ***job***'
- (modified) 'I would find the ***M-Learning MOD*** useful in my ***coursework***'

Modification of survey questions to address disparate audiences is performed by Moore in his implementation of the Innovation Diffusion Theory model.[227]

A sample tense survey item modification:

- (original) 'I ***have*** the resources necessary to use the ***system***'
- (modified) 'I ***had*** the resources necessary to use the ***M-Learning MOD***.

Venkatesh, et al. administer the UTAUT survey at three periods over the duration of six months (see table 3.6), appropriately varying the tense of questions for each survey collection time.

Table 3.6. UTAUT Longitudinal Data Collection Schedule

X	O	X	O	X	O	X	O
Training	User Reactions	System Use	User Reactions/ Usage Measurement	System Use	User Reactions/ Usage Measurement	System Use	Usage Measurement
	1 Week		1 Month		3 Months		6 Months

Time

Source: Adapted from Venkatesh, et al. "User Acceptance of Information Technology," 438.

A total of 19 survey items were modified for IS context, tense and/or vocation. Where no equivalent verbiage existed to modify survey items to reflect the target academic population of this study, the item was omitted. Consequently, one Social Influence survey item was not used (see table 3.7). The finalized survey instrument is included as appendix 14.

227. Moore, "End User Computing and Office Automation," 214-235.

Table 3.7. UTAUT Survey Item Removed from Study

UTAUT Variable	Original Survey Item	Justification for Removal
Social Influence	The senior management of this business has been helpful in the use of the system	An appropriate substitution for "Senior Management" in the academic environment would equate to Course Faculty Advisor, Department Head, Deans, etc. No such staff was available for assistance with use of the system.

Source: Investigator.

The original UTAUT survey instrument does not capture participant responses for the Experience moderator variable (MV). Rather, Venkatesh, et al. cast this MV as an indicator variable.[228] They assign a value of 0 at the beginning of their studies to indicate no experience with the Information System. Upon conclusion of a study, the variable is assigned a value of 1 to indicate experience with the system.

In this study, the Experience MV was operationalized as the number of times a participant used the M-Learning MOD (listened to the MP3 file), regardless of duration. The variable was cast with a value of 0 (did not listen) to *x* (maximum number of times a participant listened to the MP3 file). This MV was self-reported through the use of the M-Learning MOD Use Log. Experience with the M-Learning MOD increased from an initial value of 0 to that level of exposure a participant had to the system, i.e. *x* = the number of times a participant listened to the MP3 file.

The variable was assigned a value of 0 for some participants upon conclusion of the study. This value indicated that a participant never utilized the M-Learning MOD.

228. Venkatesh, et al., "User Acceptance of Information Technology," 439.

The maximum value assigned to a participant, i.e. number of times the MP3 file was listened to, was six.

An additional question was added to capture overall use of the M-Learning system. This question, “How many times did you use the M-Learning MOD?” was used as an aggregate indicator of use to complement and validate use reported in the M-Learning MOD Use Log.

3.6.4.7 MP3 File Access

During each FTF lecture the investigator wore two lapel microphones connected to each of two digital recorders. One recorder was a backup to the primary recorder. After concluding the FTF lecture, the investigator downloaded both digital recordings to a personal computer, chose that with the best fidelity, converted it to MP3 format, and posted the resulting file to the Blackboard instance associated with the appropriate lab. Students retrieved the file by entering the login ID and password they had used throughout the semester to access course Blackboard content.

Students were not provided with guidance for MP3 file manipulation other than that required to download the file from Blackboard, i.e. no directions were provided for upload to playback devices, e.g. iPods, cellular telephones, laptops, and other information appliances. Download instructions are included in appendix 8.

Treatment groups had access to the MP3 file throughout the experiment; T1 through T3. Access to the MP3 file was not granted to Control groups until T2. On average, it took less than one hour from conclusion of the FTF lecture for the Investigator to manipulate the digital audio file and post it to Blackboard.

3.7 Study Procedures

An overview of the research design is included in appendix 15.

3.7.1 T1

At T1 the Investigator provided an introduction to the study to both the FTF and Control groups (see appendix 4, appendix 5). This included a description of expectations, activities to be performed, and the incentive to participate (a $100 gift certificate to the Apple Store would be awarded to that student in each section that had the highest average grade across both quizzes).

Upon conclusion of the introduction the Investigator provided Control groups with a 20 minute FTF lecture (see appendix 7). After the lecture the Control groups returned to their regularly scheduled lab activities.

After similarly introducing the study to the Treatment groups, the Investigator announced that they would have Blackboard access to an MP3 recording of their paired section's FTF lecture at date *x* / time *y*. Copies of the M-Learning MOD Use Log (see appendix 3) were distributed and directions for completing it were provided. After these activities were completed, Treatment groups returned to regularly scheduled lab activities.

3.7.2 T1 – T2

During the period T1-T2, Treatment groups were provided with access to the M-Learning MOD; this comprised the Treatment groups being able to retrieve the MP3

recording of their paired section's FTF lecture. Over this period the groups were expected to complete the M-Learning MOD Use Log each time the M-Learning MOD was used.

3.7.3 T2

At T2 Control and Treatment groups were administered the demographics questionnaire (see appendix 9). Upon completing the questionnaire, Quiz 1 (see appendix 11) was distributed to, and completed by, both groups. Both the questionnaire and quiz were then returned to the Investigator.

Control groups were next informed that an MP3 recording of the FTF lecture they received at T1 was available on Blackboard for download. Treatment groups were informed that the file would remain accessible. Copies of the M-Learning MOD Use Log were distributed to Control groups and directions for completing it were provided. After these activities were completed Treatment and Control groups returned to regularly scheduled lab activities.

3.7.4 T2 – T3

During the period T2-T3, Treatment and Control groups were provided with access to the M-Learning MOD; this comprised both groups being able to retrieve the MP3 file from Blackboard. Over this period the groups were expected to complete the M-Learning MOD Use Log each time the M-Learning MOD was used.

3.7.5 T3

At T3 Treatment and Control groups were administered Quiz 2. Upon completing the quiz, participants completed the UTAUT survey (see appendix 14). Both the

questionnaire and quiz were then returned to the Investigator. Each participant also returned their M-Learning MOD Use Log.

Participants were then notified that study procedures had concluded. The Investigator explained that quizzes would be graded and averaged, and that average scores would be returned to lecturers for calculation of extra credit to be applied to their final course grade.

In conclusion of study procedures, it was announced by the Investigator that winners of the Apple Store gift certificate would be notified and that those participants with the highest average score across both quizzes could pick up the gift certificate at a department within the University.

3.8 Data Collection

All data gleaned from study instruments, e.g. questionnaires, surveys, quizzes, and use logs were collected by the Investigator. The Investigator was the primary coder, responsible for assessing coding consistencies, scale reliability, anomalies, and for identifying outliers. Data security and subject privacy was protected through data separation and maintenance procedures. The demographic data collected through questionnaires that could be used to identify individual students was maintained separately from survey and test data. In turn, survey data were maintained separately from test results. All data were keyed by pseudonym only.

All paper study instruments were stored in an offsite, access-controlled file cabinet. Once converted to digital format, data were stored on a password protected personal computer. Backups were made of the data which were also stored on password

protected devices. Electronic files were backed up to an external storage device daily, and to another device weekly.

3.9 Threats to Validity

Although the nonequivalent control group design does not offer the same level of immunity to internal and external validity threats as a true experiment, Campbell and Stanley note that this is one of the stronger quasi-experimental designs. There are two possible threats to internal validity: regression to the mean, and the interaction of selection and maturation. In addition, three potential threats to the external validity of the study possibly limited its generalizability. These were: interaction of testing and treatment, interaction of selection and treatment, and reactive arrangements.[229] Each threat is discussed below.[230]

3.9.1 Internal Validity

- Regression to the mean: This threat to internal validity arises in quasi-experimental settings in which a Control group is matched with a Treatment group which has been selected on the basis of the characteristic of interest. In this study, the student class sections are expected to be fairly homogenous and are randomly assigned to the treatment or control groups.

229. Campbell and Stanley, Experimental and Quasi-Experimental Designs for Research, 40.

230. Adapted from Kathleen M. Wright, "Effects of Self and Collective Efficacy Perceptions on Integrated Information Systems Task Performance." (PhD diss., George Washington University, 2004), 69.

- Interaction of selection and maturation: It is possible that the Treatment group may improve its test performance simply as a function of its maturation relative to the Control group. Both the Treatment and Control groups contain random assignment of multiple class sections, lab sections, and across individual instructors. Also, the study timeframe is relatively compressed, providing limited opportunity for differing maturation rates to create sample differentials.

3.9.2 External Validity

- Interaction of Testing and Treatment: This threat occurs as a function of the pretest observation, particularly if it sensitizes subjects to the phenomenon being studied. Campbell and Stanley note that one possible approach to eliminating this threat is to designate additional control and treatment groups that do not receive the pretest; a Solomon Four experimental design. This study employs a longitudinal design – therefore, the pretest is a necessary component for all subjects. To minimize the impact of the pretest, at T0 subjects are given only very general information about the purpose of the experiment. Also, study instruments are delivered in a manner and with scaling similar to typical student evaluation questions. This approach is intended to minimize the uniqueness of the study.
- Interaction of selection and treatment: It is possible that the treatment sample is inherently more amenable to the treatment than the control

sample, thereby reducing the generalizability of this study to other populations. This is unlikely given the random assignment of multiple sections assigned to control and treatment groups.

- Reactive Arrangements: This threat can arise when experimental procedures are perceived by subjects as singling them out, e.g. removing a portion of students from a classroom to receive treatment. In this study, students have the opportunity to compare notes with students in other class sections. This arrangement does not mitigate the Reactive Arrangements External Validity threat.

3.10 Data Analysis

3.10.1 Common-Method Variance

To proactively address common-method variance concerns, UTAUT survey items were not clustered by theme.[231]

3.10.2 Instrument Reliability

All data were entered into an SPSS[232] input file, variables created and all descriptive statistics generated. Cronbach's α coefficients[233] were then calculated for

231. P. M. Podsakoff, J. Lee, S. M. MacKenzie, and N. P. Podsakoff, "Common Method Variance in Behavioral Research: A Critical Review of the Literature and Recommended Remedies," *Journal of Applied Psychology* 88 (2003): 879-903.

232. SPSS for Windows Graduate Student Edition, Rel. 16.0.2 (Chicago: SPSS Inc., 2008).

233. L. J. Cronbach, "Coefficient Alpha and the Internal Structure of Tests," *Psychometrika* 16 (1951):297-333.

every multi-item cluster within the theme based indices (predictor variables). See section 4.4.2 for findings and discussion.

3.10.3 Factor Analyses

Factor analysis was used to see if items load as predicted on the expected number of factors. Exploratory and confirmatory factor analyses were conducted on all UTAUT survey items to arrive at a data-driven description of the constructs/factors that emerged. These procedures were executed to test the extent to which the data-driven constructs matched both à priori and *post hoc* theory-driven constructs.

3.10.3.1 Exploratory Factor Analysis

Exploratory factor analyses are typically used to explore the underlying structure of observed variables when there are no à priori hypotheses about the factor structure. In this study there *were* à priori hypotheses about the UTAUT survey factor structure. The Investigator chose to perform both exploratory and confirmatory factor analyses as it provided a unique opportunity to compare hypothesized study results with both original and study findings.

Exploratory factor analysis was performed through the generation of an unrotated factor solution. Next, a Varimax Rotation was employed from which specific constructs/factors were identified (using the criteria of Eigen-values > 1 and factor

loadings of |.3| and greater).[234] This method was used to confirm the discriminant and construct validity of the survey items.[235] See section 4.4.3 for findings and discussion.

3.10.3.2 Structural Equations Modeling

Through the use of structural equations modeling a Confirmatory factor analysis (CFA) was conducted to determine whether the number of factors and the loadings of predictor variables on them conformed to what was expected on the basis of pre-established theory, in this case the prior studies conducted by Venkatesh, et al. In summary, determinations of variable loadings on factors were made *post hoc*.

The Investigator's à priori assumption was that each factor was associated with a specific subset of survey items. "A minimum requirement of confirmatory factor analysis is that one hypothesize beforehand the number of factors in the model, but usually the researcher will also posit expectations about which [items] will load on which factors."[236] In summary, the Investigator sought to determine if measures created to represent a latent variable really belonged together. See section 4.4.4 for findings and discussion.

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234. Christopher David Godsil, and Gordon Royle, *Algebraic Graph Theory* (NY: Springer-Verlag, 2001).

235. G. David Garson, "Factor Analysis," The North Carolina State University, http://www2.chass.ncsu.edu/garson/pa765/factor.htm (accessed February 29, 2008).

236. Jae-On Kim and Charles W. Mueller, "Factor Analysis: Statistical Methods and Practical Issues," *Quantitative Applications in the Social Sciences*, 14 (1978): 55.

3.10.4 Correlation Matrix

Using SPSS a correlation matrix was produced (Pearson Product Moment correlation – Pearson's r) to determine the correlations between each variable in the modified UTAUT model (see section 4.4.5).

3.10.5 Hypotheses Testing

The overall plan assessed hypotheses 1a – 6e using multiple regression, given that there were multiple predictor variables and à priori assumptions about the relative weight of each of these. The rationale for the approach was that it was hypothesized that the Mode of Delivery Predictor Variable would likely account for the greatest number of variability in Performance; while the Predictor Variables Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Behavioral Intention, and Use Behavior would account for the 2nd greatest amount of variability in Performance. It was hypothesized that Mediator Variables Gender, Age, Experience, and Voluntariness of Use would account for the least amount of variability in Performance. All interaction effects and corresponding main effects were tested within the context of a hierarchical multiple regression.[237]

237. L. S. Aiken, and S. G. West, *Multiple Regression: Testing and Interpreting Interactions* (Newbury Park, CA: Sage, 1991); Reuben M. Barron, and David A. Kenny, "The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations," *Journal of Personality and Social Psychology* 51, no. 6 (1986).

Chapter 4 Results

4.1 Introduction

In this chapter the methods used to perform hypotheses testing are discussed. All study data were entered into an SPSS input file, variables were created and descriptive statistics were generated.

Data analysis procedures were conducted consistent with section 3.10. Table 4.1 presents an index of data analysis procedures as they appear in this chapter.

Table 4.1. Index of Data Analysis Procedures

Method
1. Participant Statistics (see section 4.2) a. Descriptive Statistics (see section 4.2.1) b. Frequency Tables (section 4.2.2)
2. Power Analysis (see section 4.3)
3. Common Method Variance (see section 4.4.1)
4. Instrument Reliability (section 4.4.2)
5. Exploratory Factor Analysis (see section 4.4.3)
6. Confirmatory Factor Analysis (see section 4.4.4)
7. Correlation Matrix (see section 4.4.5)
8. Hypotheses Testing (see section 0)

Source: Investigator.

4.2 Participants

One hundred and eighty students out of a total of 266 eligible students across seven sections of an undergraduate Introduction to Information Systems course participated in the study – a 68% participation rate. One hundred and eight of the 180 participating students completed all requirements across the three contact times – 60% of

participants; 41% of eligible students. Thus, 108 students were considered eligible for inclusion in data analysis procedures (see table 4.2).

Table 4.2. Participant Statistics

Population Description	Participants	Rate	
Number of Eligible Participants	266		
Number of Eligible Students that Opted to Participate	180		
Participation Rate		68%	
Number of Participants Completing all Study Procedures	108		
% of Participants Eligible for Inclusion in Data Analyses		60%	
Percentage of Eligible Participants included in Study			41%

Source: Investigator.

4.2.1 Demographic Statistics

The average age of participants was 19.47 years (see table 4.3).

Table 4.3. Demographic Statistics – Age

Minimum	Maximum	Mean
18	25	19.47

Source: Investigator.

Gender was evenly distributed – 49% male, 51% female. A preponderance of participants were white – 66.7%. Asians were the next most represented race – 12% participated in the study. 59% of the participants were sophomores, 32.4% juniors, and 4.6% comprised seniors/other. Finance was the most represented major – 41.6%. The next most represented major was Accounting – 13.8%. IS majors made up only 2.8% of participants (see table 4.4).

Table 4.4. Demographic Statistics, cont.

Demographic		Frequency	%
Gender	Female	54	50.0
	Male	53	49.0
	Not Reported	1	1.0
Race	White	72	66.7
	Asian	13	12.0
	Other	10	9.3
	Indian	6	5.6
	African American	4	3.7
	Hispanic	2	1.9
Class Standing	Sophomore	59	54.6
	Freshman	35	32.4
	Junior	8	7.4
	Senior	4	3.7
	Other	1	.9
Field of Study	Finance	45	41.6
	Accounting	15	13.8
	Marketing	14	12.9
	International Business	13	12.0
	Other	10	9.3
	Sports, Event and Hospitality Management	4	3.7
	Business Economics and Public Policy	3	2.8
	Information Systems	3	2.8
	Management	1	1.0

Source: Investigator.

4.2.2 Item Frequency Tables

Item frequency tables are provided in appendix 10. Grouped by variable, the tables list items, responses, frequency of responses, percent of responses, and cumulative percentage of responses.

4.3 Power Analysis

> Statistical power analysis exploits the relationships among the four variables involved in statistical inference: sample size (*N*), significance criterion (α), population effect size (ES), and statistical power. For any statistical model, these relationships are such that each is a function of the other three. For example, in power reviews, for any given statistical test, we can determine power for a given α, *N*, and ES. For research planning, however, it is most useful to determine the N necessary to have a specified power for a given α and ES.[238]

Statistical power is the probability that a meaningful difference, or effect, will be detected if one was to occur. Ideally, studies should have power levels of 0.80 or higher; an 80% chance or greater of finding an effect if one was really there.[239]

This study included 10 predictor variables and an á priori α value (statistical significance level) of .05. An Effect Size (ES) of .50 and Cohen's recommended Power of .80 was adopted. [240] Multiple regression was used to test all of the hypotheses. As per Cohen[241], the minimum required sample size (*N*) per group was calculated as 43, which required a total of 86 participants meeting the requirements.

The actual study *N* was 108 – evenly distributed between Control and Treatment groups.

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238. Jacob Cohen, "Quantitative Methods in Psychology – A Power Primer," *Psychological Bulletin* 112, no. 1 (1992): 156.

239. The National Comprehensive Center for Teacher Quality, "Glossary," s.v. "Statistical Power," http://www.ncrel.org/tech/claims/glossary.html (accessed August 21, 2008).

240. Cohen, "Quantitative Methods," 156.; Daniel Soper, "Statistics Calculators", http://www.danielsoper.com/statcalc/calc01.aspx (accessed August 21, 2008). Also known as the p-value, probability, or type I error rate. By convention, this value should be less than or equal to 0.05 to claim statistical significance.

241. Cohen, "Quantitative Methods," 158.

4.4 Data Analysis Procedures

Study survey items used in estimating UTAUT (appendix 14) were adapted from Venkatesh, et al. (appendix 13).[242] Two additional items were added to the study survey: 1) Voluntariness of Use (VOL), and 2) Use Behavior (UB) (see table 4.5).

Table 4.5. Additional Survey Items.

Item Number	Question				
1	I felt that using the M-Learning MOD was voluntary (VOL)				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	1	2	3	4	5
2	How many times did you use the M-Learning MOD? (UB)				
	Never	1-5 times	6-10 times	11-15 times	> 15 times
	1	2	3	4	5

Source: Investigator.

Item 1, used to measure Voluntariness of Use (VOL) was introduced in Moore and Benbasat's Information Technology Innovation Adoption research,[243] and was not measured in the original UTAUT survey. The item was included as a moderator in the adapted study model. Moore and Benbasat used a seven-point Likert Scale to measure VOL: 1 was considered nonvoluntary and 7 indicated complete voluntariness.[244] In this study the scale was reduced to 5 items to maintain parity with other variable measures in the study.

242. Venkatesh, et al., "User Acceptance of Information Technology," 460.

243. Moore and Benbasat, "Development of an Instrument," 195.

244. Moore and Benbasat, "Development of an Instrument," 192-222.

Item 2 was added to determine whether participants' perception of Use Behavior (UB) was consistent with actual usage as gauged by the M-Learning MOD Use Log (see appendix 3).

Question 4, "The M-Learning MOD was not compatible with other systems I use" was reverse-scored:

> The use of negatively worded items (items that are worded so a positive response indicates a 'lack' of the [variable] are mainly used to eliminate or attenuate response pattern bias or response set. Response pattern bias is where the respondent simply goes down the page without really reading the questions thoroughly and circles all '4's for a response to all the questions. With reverse-scored items, the thought is that the respondent will have to think about the response because the answer is 'reversed'.[245]

4.4.1 Common Method Variance

To proactively address common-method variance concerns, UTAUT survey items were not clustered by theme.[246] This procedure was performed to mitigate the effects of common-method variance, ". . . variance that is attributed to the measurement method rather then the constructs of interest [which] may cause systematic measurement error and further bias the estimates of the true relationship among theoretical constructs."[247] As per Aiken and West, non-dichotomous Predictor and Moderator variables were centered

245. Cheri A. Young, "Validity Issues in Measuring Psychological Constructs," Cornell University, (accessed August 16, 2008) http://www.socialresearchmethods.net/tutorial/Young/eiweb2.htm.

246. P. M. Podsakoff, J. Lee, S. M. MacKenzie, and N. P. Podsakoff, "Common Method Variance in Behavioral Research: A Critical Review of the Literature and Recommended Remedies," *Journal of Applied Psychology* 88 (2003): 879-903.

247. Zencaroline, "The Only Thing Unchanged is Change," under "Common Method Variance," http://zencaroline.blogspot.com/2007/04/common-method-variance.html (accessed August 16, 2008).

on their mean prior to calculation interaction effects. Centered Predictor and Moderator variables were also used in direct-effect relationships.[248]

4.4.2 Instrument Reliability

A reliability analysis using Cronbach's α was conducted to estimate the reliability of the predictor variables. The generally agreed upon lower limit for Cronbach's α is 0.70 (this value may decrease to 0.60 in exploratory research). At .70 the standard error of measurement will be over half (0.55) a standard deviation. [249]

Cronbach's α coefficients were calculated for each multi-item predictor variable. Moderator variables were not checked for reliability because each variable comprised a single item.

The modified UTAUT survey instrument proved reliable with Cronbach's α coefficients above 0.7 for all Predictor Variables with the exception of Facilitating Conditions (0.63) (see table 4.6). The results of the iterations of reliability analysis procedures per variable are included as appendix 16.

248. Leona S. Aiken and Stephen G. West, *Multiple Regression: Testing and Interpreting Interactions* (CA: Sage Publications, 1991).

249. J. F. Hair, R. E. Anderson, R. L. Tatham, and W. C. Black, *Multivariate Data Analysis* (NJ: Prentice-Hall, 1998); L. J. Cronbach, "Coefficient Alpha and the Internal Structure of Tests," *Psychometrika* 16 (1951): 297-333.

Table 4.6. Instrument Reliability Summary

Variable	# Items	α	Variable Type
Behavioral Intention	3	.930	Predictor
Effort Expectancy	4	.908	Predictor
Facilitating Conditions	4	.630	Predictor
Performance Expectancy	4	.821	Predictor
Social Influence	3	.731	Predictor
Gender	1	n/a	Moderator
Age	1	n/a	Moderator
Mode of Delivery	1	n/a	Moderator
Voluntariness of Use	1	n/a	Moderator
Experience	1	n/a	Moderator

Source: Investigator.

4.4.2.1 Discussion

Table 4.7 shows instrument reliability results if survey item 16 was deleted: "A specific person (or group) was available for assistance with M-Learning MOD difficulties" (see appendix 9). The item is one of four used to measure Facilitating Conditions.

Table 4.7. Item-Total Statistics – Facilitating Conditions. (r) = Reverse Scored.

Item	Cronbach's α if Item Deleted
Q04 FC(r)	.433
Q09 FC	.436
Q13 FC	.419
Q16 FC	.781

Source: Investigator.

Item 16 may have lowered reliability for Facilitating Conditions due to its wording. Although it was never explicitly stated that support resources were available (none was available), it is quite likely that students perceived that such resources were, in fact, provided, e.g. office hours, ad-hoc in-lab/classroom questions, etc.

No M-Learning MOD issues were raised by participants over the duration of the study but this does not mean that students *felt* that support was available. In summary, the nature of historically available classroom support may have created the perception of actual support during the study.

4.4.3 Exploratory Factor Analysis (EFA)

Cluster validation via EFA was performed using SPSS. Principal Component Factor Analysis (PCA) with Varimax Rotation (Kaiser Normalization) was employed. [250] To ensure that factor loadings were accounting for at least 10% of the variance in the overall model, the criteria of Eigen-values > 1 and factor loadings of |.3| and greater were employed.[251] The results are presented in table 4.8.

Although it was anticipated à priori that the 18 survey items would load onto the 5 variables (components) identified by Venkatesh, et al., only 3 components emerged. Items that loaded onto each component were grouped and determined by the Investigator to represent: 1) M-Learning MOD Ease of Use and Self Efficacy, 2) M-Learning MOD Use and Effectiveness, and 3) Peer Influence. Components are discussed in sections 4.4.3.1 through 4.4.3.3. It was not determined why cross-loadings occurred.

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250. G. David Garson, "Factor Analysis", North Carolina State University College of Humanities and Social Science, http://www2.chass.ncsu.edu/garson/pa765/factor.htm (accessed August 21, 2008). By far the most common form of factor analysis, PCA seeks a linear combination of variables such that the maximum variance is extracted from the variables. It then removes this variance and seeks a second linear combination which explains the maximum proportion of the remaining variance, and so on. This is called the principal axis method and results in orthogonal (uncorrelated) factors. PCA analyzes total (common and unique) variance.

251. Christopher David Godsil, and Gordon Royle, *Algebraic Graph Theory* (NY: Springer-Verlag, 2001).

Table 4.8. Exploratory Factor Analysis: Rotated Component Matrix – Values Shown are > |.3|. (r) = Reverse Scored.

	Component		
Item	1	2	3
I intend to use the M-Learning MOD if offered in other courses		.905	
I plan to use the M-Learning MOD if offered in other courses		.907	
I predict I would use the M-Learning MOD if offered in other courses		.856	
I found the M-Learning MOD easy to use	.866		
Learning to operate the M-Learning MOD was easy for me	.874		
It was easy for me to become skillful at using the M-Learning MOD	.835		
My interaction with the M-Learning MOD was clear and understandable	.758		
The M-Learning MOD was not compatible with other systems I use	.729		
I had the resources necessary to use the M-Learning MOD	.764		
I had the knowledge necessary to use the M-Learning MOD	.756		
A specific person (or group) was available for assistance with M-Learning MOD difficulties			.658
Using the M-Learning MOD enabled me to accomplish tasks more quickly		.550	.417
Using the M-Learning MOD increased my productivity		.670	.394
I found the M-Learning MOD useful in my coursework		.610	.400
If I continue to use the M-Learning MOD, I will increase my chances of getting a better grade		.745	
People who influence my behavior thought that I should use the M-Learning MOD			.772
People who are important to me thought that I should use the M-Learning MOD			.813
In general, the organization supported the use of the M-Learning MOD		.490	.335

Source: Investigator.

4.4.3.1 Component 1: M-Learning MOD Ease of Use and Self Efficacy

The Ease and Self Efficacy components were characterized by seven items with factor loadings ranging from .729 - .874. The items' commonalities are described below:

Ease of Use: Items focused on participants' perceptions of M-Learning MOD ease of use: It was easy to become skillful with the M-Learning MOD; overall, the M-Learning MOD was easy to use.

Self Efficacy: I had the resources necessary to use the M-Learning MOD; I had the knowledge necessary to use the M-Learning MOD, etc.

4.4.3.2 Component 2: M-Learning MOD Use and Effectiveness

M-Learning MOD Use and Effectiveness characteristics comprise eight items with factor loadings ranging from .490 - .907 The items' commonalities are described below:

Use: Items focus on intended use of the M-Learning MOD: I *intend* to use the M-Learning MOD if offered in other courses; I *plan* to use the M-Learning MOD if offered in other courses, etc.

Application: Items focus on the effectiveness of the M-Learning MOD: The M-Learning MOD increased my productivity; The M-Learning MOD enabled me to accomplish tasks more quickly, etc.

4.4.3.3 Component 3: Peer Influence

The Peer Influence component was characterized by seven items with factor loadings ranging from .335 - .813. The items' commonalities are described below:

People who influence my behavior thought that I should use the M-Learning MOD.

People who are important to me thought that I should use the M-Learning MOD, etc.

4.4.4 Confirmatory Factor Analysis (CFA)

A CFA of the data was performed using AMOS[252] (see figure 4.1, table 4.9).

The largest % of variance was accounted for by Effort Expectancy (EE), item 10, standardized regression weight = .94, r^2 = .89. The least amount of variance was accounted for by the FC item 16, standardized regression weight = .13, r2 = .02.

Based on the fit indices, post hoc suppositions regarding item loadings on variables were validated with the exception of item 16. These findings are consistent with the Exploratory Factor Analysis discussed previously which found that eliminating item 16 would raise the α coefficient for Facilitating Conditions from .630 to .781.

Considering the strength of other factor loadings for FC and other arguments in the literature against modifying instruments as a result of Confirmatory Factor Analyses, it was decided that all survey items would remain.[253]

252. AMOS 16.0, Rel. 16.0.1 (Spring House, PA: AMOS Development Corporation, 2007).

253. S. L. Crowley and X. Fan, "Structural equation modeling: basic concepts and applications in personality assessment research," *Journal of Personality Assessment*, 68, no. 3 (1997): 508-531.

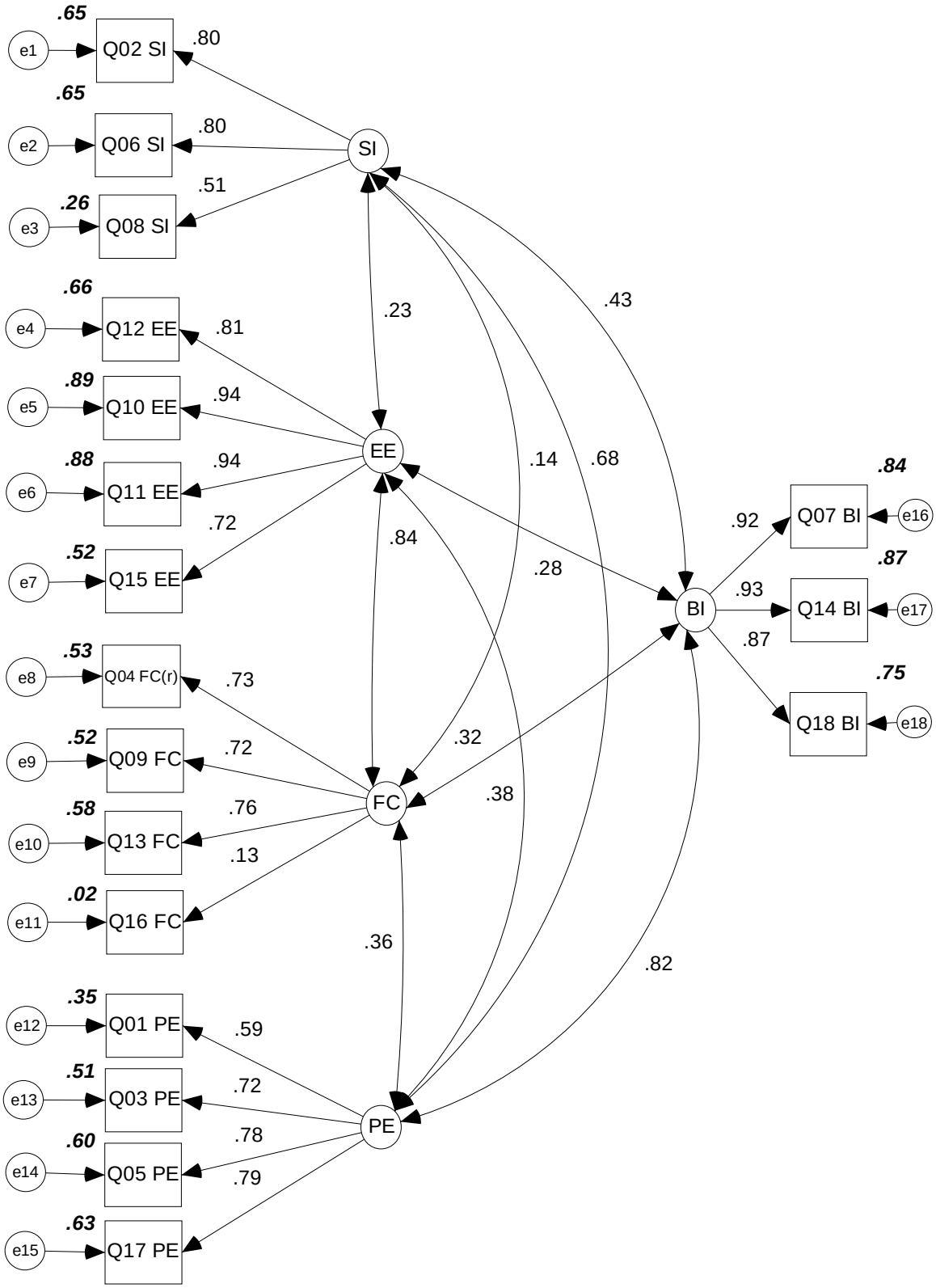

Figure 4.1. Confirmatory Factor Analysis. (r) = Reverse Scored. *Source*: Investigator.

Table 4.9. Confirmatory Factor Analysis- Item Standardized Regression Weights and R2 - Sorted Ascending by Variable Name, Descending by Item R2

Variable	Item	Standardized Regression Weight	R2
Behavioral Intention	14	.87	.93
	7	.84	.92
	18	.75	.87
Effort Expectancy	10	.94	.89
	11	.94	.88
	12	.81	.66
	15	.72	.52
Facilitating Conditions	13	.76	.58
	4	.73	.53
	9	.72	.52
	16	.13	.02
Performance Expectancy	17	.79	.63
	5	.78	.60
	3	.72	.51
	1	.59	.35

Source: Investigator.

4.4.5 Correlation Matrix

All Predictor Variables were significantly correlated with one another at the $p<.05$ level (see table 4.10). As anticipated, most single item indexed variables were not significantly correlated (e.g. EXP - Experience, GDR – Gender, AGE, MOD – Mode of Delivery, VOL - Voluntariness) (see table 4.11). The R^2 values should be consulted to determine the 'real world' significance of the statistically significant relationships.

Table 4.10. Predictor Variable Significance

Indexed Variable		PE	EE	SI	FC	BI
PE (Performance Expectancy)	R^2	1.000				
	Sig. (2-tailed)					
EE (Effort Expectancy)	R^2	.115**	1.000			
	Sig. (2-tailed)	.000				
SI (Social Influence)	R^2	.344**	.066**	1.000		
	Sig. (2-tailed)	.000	.008			
FC (Facilitating Conditions)	R^2	.128**	.562**	.108**	1.000	
	Sig. (2-tailed)	.000	.000	.001		
BI (Behavioral Intention)	R^2	.501**	.078**	.199**	.107**	1.000
	Sig. (2-tailed)	.000	.004	.000	.001	

Source: Investigator.

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 4.11. Correlation Matrix

Indexed Variables	ICR	Mean	SD		PE	EE	SI	FC	BI	EXP	GDR	AGE	MOD	VOL
PE	.82	3.15	.67	Pearson Correlation	1.000									
				Sig. (2-tailed)										
EE	.91	4.02	.72	Pearson Correlation	.339**	1.000								
				Sig. (2-tailed)	.000									
SI	.73	3.11	.60	Pearson Correlation	.587**	.258**	1.000							
				Sig. (2-tailed)	.000	.008								
FC	.63	3.84	.57	Pearson Correlation	.359**	.750**	.329**	1.000						
				Sig. (2-tailed)	.000	.000	.001							
BI	.93	3.44	.86	Pearson Correlation	.708**	.280**	.447**	.327**	1.000					
				Sig. (2-tailed)	.000	.004	.000	.001						
EXP	n/a	9.95	3.80	Pearson Correlation	-.029	.140	.047	.245*	-.044	1.000				
				Sig. (2-tailed)	.770	.153	.634	.013	.655					
GDR	n/a	.50	.50	Pearson Correlation	.031	.220*	-.055	.100	.053	-.042	1.000			
				Sig. (2-tailed)	.752	.025	.577	.321	.590	.669				
AGE	n/a	19.47	1.15	Pearson Correlation	.167	-.173	.134	-.082	.098	.104	.045	1.000		
				Sig. (2-tailed)	.090	.080	.174	.415	.318	.286	.645			
MOD	n/a	.47	.50	Pearson Correlation	-.025	.157	.042	.271**	-.058	.983**	-.046	.076	1.000	
				Sig. (2-tailed)	.800	.110	.669	.006	.555	.000	.636	.438		
VOL	n/a	4.10	.93	Pearson Correlation	.027	.087	.107	.123	-.104	.016	.008	-.195*	.038	1.000
				Sig. (2-tailed)	.784	.377	.274	.222	.285	.871	.935	.045	.701	

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

4.4.5.1 Discussion

A summary of the significant correlations noted in table 4.11 can be found in table 4.12.

Table 4.12. Summary of Significant Correlations

Indexed Variables	ICR	Mean	SD		PE	EE	SI	FC	EXP	AGE
EE	.91	4.02	.72	Pearson Correlation	.339**					
				Sig. (2-tailed)	.000					
SI	.73	3.11	.60	Pearson Correlation	.587**	.258**				
				Sig. (2-tailed)	.000	.008				
FC	.63	3.84	.57	Pearson Correlation	.359**	.750**	.329**			
				Sig. (2-tailed)	.000	.000	.001			
BI	.93	3.44	.86	Pearson Correlation	.708**	.280**	.447**	.327**		
				Sig. (2-tailed)	.000	.004	.000	.001		
EXP	n/a	9.95	3.80	Pearson Correlation				.245*		
				Sig. (2-tailed)				.013		
GDR	n/a	.50	.50	Pearson Correlation		.220*				
				Sig. (2-tailed)		.025				
MOD	n/a	.47	.50	Pearson Correlation				.271**	.983**	
				Sig. (2-tailed)				.006	.000	
VOL	n/a	4.10	.93	Pearson Correlation						-.195*
				Sig. (2-tailed)						.045

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

The correlation matrices in table 4.11 and table 4.12 indicate the intercorrelations between all indexed variables; PVs, IVs, and MVs. Significant relationships are denoted with asterisks – correlations are significant at ≤ .05.

ICR is a measure of the reliability of different survey items' ability to measure the same characteristic. Each IV and PV survey item was measured on a 5 point Likert scale: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5).

Item responses from a particular study participant are expected to be varied across a given variable, even though the items were intended to measure the same variable. Across participants, a small variability in item responses on indexed variables is desirable. The smaller this variability (or stronger the correlation), the greater the ICR value will be. ICR values range from .63 to .93 in the summarized table. As per Cohen, these values, for the participants in the study, are within the acceptable cutoff range (.5 to 1.0). [254]

The Mean values represent the average response to each indexed variable. This measure is calculated by summing all response values in the Likert scale across all respondents and then dividing by the number of participants. This measure has no statistical significance on its own, but is a vital component of the equation used to calculate a variable's Standard Deviation.

The Standard Deviation (SD) for each indexed variable represents the measure of the dispersion of outcomes around the Mean. If the Mean value represents the data, then most of the scores will cluster close to the Mean and the resulting SD will be small

254. J. Cohen, *Statistical Power Analysis for the Behavioral Sciences,* 2nd ed. (Hillsdale, NJ: Lawrence Erlbaum and Associates, 1988).

relative to the Mean. *With the exception of MOD and GDR, this relationship holds true*. In the case of MOD and GDR, the SD is equal to the Mean – this situation occurs because MOD and GDR are evenly divided across the study population.

The Pearson Correlation (Pearson's product-moment correlation coefficient) is a standardized measure of the strength of the relationship between two indexed variables.

> It can take on any value from -1 (as one variable changes, the other changes in the opposite direction by the same amount [i.e., no effect]) through 0 (as one variable changes the other doesn't change at all), to +1 (as one variable changes, the other changes in the same direction by the same amount [i.e., no effect]).[255]

An indexed variables will always be perfectly correlated with itself; examples of perfectly correlated variables (Pearson's Correlation = +1) can be seen in table 4.10 by matching any variable in a row to the same variable in a column. Each Pearson Correlation value in the table is a measure of the probability (*p*) that a reported correlation value would occur by chance across the 108 participant sample.

The Pearson correlation (see table 4.10) affords the following statistically significant inferences:

1. As Effort Expectancy increases, Performance Expectancy will increase.
2. As Social Influence increases, Performance Expectancy and Effort Expectancy will increase.
3. As Facilitating Conditions increases, Performance Expectancy, Effort Expectancy, and Social Influence will increase.
4. As Behavioral Intention increases, Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions increase.

255. Andy Field, *Discovering Statistics using SPSS*. 2nd ed. (London: Sage Publications, 2005).

5. As Experience increases, Facilitating Conditions increases.

6. As Gender increases, Effort Expectancy increases.

7. As Mode of Delivery increases (0 = FTF, 1 = M-Learning), Facilitating Conditions and Experience increase.

8. As Age decreases, Voluntariness of Use increases, i.e. there is a negative relationship between the two variables.

4.4.6 Results of Hypotheses Testing

4.4.6.1 H1a

Table 4.13. Summary of Hypotheses Testing – H1a.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H1a	The effect of Performance Expectancy (PE) on Behavioral Intention (BI) will be moderated by Gender (GDR) such that the effect will be stronger for men.	Not Supported	BI	PE	GDR	0.619

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

No significant effect on BI was found to be associated with the interaction between PE and GDR. The original hypothesis as presented by Venkatesh, et al. included Age as a moderator and *was* found to be significant. It may be the case, then, that if AGE was incorporated as a moderator a significant interaction between BI, PE, and GDR would have been found.

A direct effect *was* found between PE and BI (p=.001, Adjusted R^2 = .501). This is consistent with the findings of Venkatesh, et al., This might be an indication that participants who expected to perform better on quizzes planned to use the M-Learning MOD more than those who did not anticipate performing at a high level.

4.4.6.2 H1b

Table 4.14. Summary of Hypotheses Testing – H1b.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H1b	The effect of Performance Expectancy (PE) on Behavioral Intention (BI) will be moderated by Mode of Delivery (MOD).	Not Supported	BI	PE	MOD	0.718

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

No significant effect on BI was found to be associated with the interaction between PE and MOD. However, a direct effect was found between PE and BI (p =.001, Adjusted R^2 = .502). The p value and Adjusted R^2 in this hypothesis are almost identical to that found in H1a. It would appear that neither GDR nor MOD affect the direct relationship. Of note is that GDR and MOD were both randomly, yet evenly split among participants.

4.4.6.3 H2a

Table 4.15. Summary of Hypotheses Testing – H2a.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H2a	The effect of Effort Expectancy (EE) on Behavioral Intention (BI) will be moderated by Gender (GDR) and Experience (EXP) such that the effect will be stronger for women and particularly at early stages of exposure to the M-Learning MOD.	Not Supported	BI	EE	GDR EXP	0.057

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

The effect of the interaction between EE, GDR, and EXP on BI was found to be slightly above the established á priori p value of .05. At p=.057 this hypothesis was not supported. As EE interacts with GDR and EXP, BI increases. [In other words, as participants' familiarity with the system (EXP) increases, this may in turn drive them to consider using the M-Learning MOD more – (BI)].

Venkatesh, et al.'s studies dummy coded EXP as 0, 1, or 2 (T1, T2, and T3, respectively) while in this study, EXP was operationalized as the exact number of times the M-Learning MOD was actually used. Surprisingly, the hypothesis was marginally supported even with the difference in scale.

4.4.6.4 H2b

Table 4.16. Summary of Hypotheses Testing – H2b.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H2b	The effect of Effort Expectancy (EE) on Behavioral Intention (BI) will be moderated by Mode of Delivery (MOD).	Not Supported	BI	EE	MOD	0.841

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

The effect of EE on BI with interaction terms MOD and EE was not found to be significant. However, a direct effect was found between EE and BI (p = .012, Adjusted R^2 = .068).

Primarily, the modified UTAUT model was hypothesized to significantly affect PERF as stated in hypotheses H6a – H6e. Here, it may be that the result of testing the MOD*EE interaction fails to be significant because the M-Learning MOD was considered to be of no more or less effort than attending a lecture – both of which are listening activities.

4.4.6.5 H3a

Table 4.17. Summary of Hypotheses Testing – H3a.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H3a	The effect of Social Influence (SI) on Behavioral Intention (BI) will be moderated by Gender, Experience (EXP), and Voluntariness (VOL) such that the effect will be stronger for women particularly in mandatory settings in the early stages of Experience with the M-Learning MOD.	Not Supported	BI	SI	GDR EXP VOL	0.708

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

Although a significant effect was not found when the BI was regressed upon the interaction of GDR, EXP, VOL, and SI, a direct, significant effect was discovered in relationship between SI and BI (p=.000; Adjusted R^2 .575). Venkatesh, et al. hypothesized that AGE would impact the hypothesis because "older workers are more likely to place increased salience on social influences, with the effect declining with experience."[256] AGE was not included in the study UTAUT model due to the age-homogeneity of participants.

256. Venkatesh, et al., "User Acceptance of Information Technology," 453.

4.4.6.6 H3b

Table 4.18. Summary of Hypotheses Testing – H3b.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H3b	The effect of Social Influence (SI) on Behavioral Intention (BI) will be moderated by Mode of Delivery (MOD).	Not Supported	BI	SI	MOD	0.848

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

This interaction was not found to be non-significant. This hypothesis was included to assess the impact of MOD on the relationship assessed in H3a (BI on SI with GDR, EXP, and VOL as moderators). Of note is that the direct effect of BI on SI was again found to be significant (p=.002; Adjusted R^2 =.192). Although the direct effect is slightly less significant than in H3a (.002 vs. .000), and the R^2 significantly lower than in H3a (.192 vs.575), a relationship does, nonetheless, exist. This appears to indicate that the influence of friends and others important to participants (SI) was associates with heightened BI, but was not enough to actually drive use through the influence of BI.

4.4.6.7 H4a

Table 4.19. Summary of Hypotheses Testing – H4a.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H4a	The effect of Facilitating Conditions (FC) will not have a significant influence on Behavioral Intention (BI).	Not Supported (prediction of null-effect not supported)	UB	FC	-	0.001**

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

The null effect anticipated was not supported; a significant p value of .001 indicated that there was a direct effect between FC and UB. Item frequency tables (see appendix 10) show that participants felt that conditions did facilitate use of the M-Learning MOD:

1. The M-Learning MOD was not compatible with other systems I use: Neutral
2. I had the resources necessary to use the M-Learning MOD: Agree
3. I had the knowledge necessary to use the M-Learning MOD: Agree
4. A specific person (or group) was available for assistance with M-Learning MOD difficulties: Neutral

With facilitating conditions present, it could be surmised that use of the M-Learning MOD directly occurs because participants perceive that assistance will be there if they encounter issues while using the M-Learning MOD.

4.4.6.8 H4b

Table 4.20. Summary of Hypotheses Testing – H4b.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H4b	The effect of Facilitating Conditions (FC) on M-Learning Use Behavior will be moderated by Experience (EXP) with the M-Learning MOD such that the effect will be stronger for students with increasing Experience (EXP).	Not Supported	UB	FC	EXP	0.193

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

In H4a, it was found that the relationship between FC and UB was significant. However, with the MV EXP included in the hypothesis, no significance is found. The direct effect of UB on EXP was p=.000; Adjusted R^2 .166. In light of the correlation matrix that reported a FC:EXP Pearson Correlation of .245 and Significance of .013, it would otherwise seem unlikely that FC*EXP would be associated with a decrease in the total significance of the hypothesis.

4.4.6.9 H4c

Table 4.21. Summary of Hypotheses Testing – H4c.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H4c	The effect of Facilitating Conditions (FC) on M-Learning MOD Use Behavior will be moderated by Mode of Delivery (MOD).	Not Supported	UB	FC	MOD	0.157

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

Although the hypothesis was not supported, the direct effect of MOD on UB was p=.000 with an Adjusted R^2 =.155. Interestingly, with MOD comprised of FTF and M-Learning MOD use, as UB increases it may be implied that: 1) as FTF users are introduced to the M-Learning MOD their UB is driven up due their desire to 'catch up' with their counterparts, or 2) M-Learning MOD users, once introduced to the system, use it more frequently.

4.4.6.10 H5

Table 4.22. Summary of Hypotheses Testing – H5.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H5	The effect of Behavioral Intention (BI) on M-Learning MOD Use Behavior (UB) will be moderated by Gender (GDR)	Not Supported	UB	BI	GDR	0.556

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

GDR does not, when interacting with BI, have an effect on UB. No significant relationship existed in the two direct effect paths: UB on BI, UB on GDR. The results of hypothesis testing (including direct effect testing) infers that intention to use does not drive actual behavior, that GDR has no impact on UB, and that BI*GDR has no effect on UB. GDR was evenly divided between males and females which might possibly explain the lack of interaction or direct effect; if it does, it implies that neither gender used the system more than the other.

In the case of BI, it is interesting that this IV does not directly affect UB. It would seem that the more a participant intends to use the system, the more they would actually use it.

4.4.6.11 H6a

Table 4.23. Summary of Hypotheses Testing – H6a.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H6a	Mode of Delivery (MOD) will have an influence on Quiz 1 Performance (PERF Q1).	Supported	PERF Q1	-	MOD	0.000***

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

The direct effect of MOD on PERF Q1 was significant at p=.000; Adjusted R^2 =.106. This direct effect result implies that MOD has a significant impact on PERF – in this case, PERF Q1. This direct effect lies at the heart of the Media Comparison Study. The relationship was further explored to determine which mode (FTF or M-Learning MOD) had a greater impact on PERF Q1 (see table 4.24).

Table 4.24. H6a Group Statistics

	MOD	N	Mean	Std. Deviation	Std. Error Mean
PERF Q1:	FTF	57	.6491	.08582	.01137
	M-Learning MOD	51	.5627	.15161	.02123

Source: Investigator.

There is a 9% increase in average score on Quiz 1 between the FTF and M-Learning MOD groups (see table 4.24). The FTF group performed better than the M-Learning MOD group. The number of participants in each study group (Control = FTF, Treatment = M-Learning MOD) are approximately equal.

This finding addresses Research Question 1 at T2 when effectiveness is operationalized as performance. Research question 1 is, “Is the M-Learning MOD more

or less effective than FTF?" The findings of this hypothesis imply that the M-Learning MOD is not as effective as FTF. This research question is further explored in hypothesis H6b (page 161) to discover whether MOD is significant at T3, Quiz 2.

4.4.6.12 H6b

Table 4.25. Summary of Hypotheses Testing – H6b.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H6b	Mode of Delivery (MOD) will have an influence on Quiz 2 Performance (PERF Q2).	Supported	PERF Q2	MOD	-	0.010***

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

The direct effect of MOD on PERF Q2 at T3 was significant at p=.010; Adjusted R^2=.052. This direct effect result implies that MOD has an impact on PERF. The p value is greater than that which resulted from the exploration of the direct effect of MOD on Quiz 1. In addition, the Adjusted R^2 is nearly half as large as that seen in H6a which explored the impact of MOD on Quiz 1. Thus, MOD did not account for as much of the variance in Quiz 2 performance as it did on Quiz 1 performance.

The relationship between MOD and PERF Q2 was further explored to determine which mode (FTF or M-Learning MOD) had a greater impact on PERF Q2 (see table 4.26).

Table 4.26. H6b Group Statistics

	MOD	N	Mean	Std. Deviation	Std. Error Mean
PERF Q2:	FTF	57	.6579	.12635	.01673
	M-Learning MOD	51	.5873	.15357	.02150

Source: Investigator.

There is a 7% increase in average score on Quiz 2 between the FTF and M-Learning MOD groups (see table 4.26). The FTF group performed better than the M-

Learning MOD group. The number of participants in each study group (Control = FTF, Treatment = M-Learning MOD) is approximately equal. In the presence of these statistics, it is not hypothesized that the number of test scores had an effect on the average quiz scores between the two groups.

This finding addresses Research Question 1 at T2, Quiz 2. The findings of this hypothesis imply that the M-Learning MOD is not as effective as FTF. Of note, however, is that the difference in average scores on Quiz 1 is 9%, while the difference in average scores on Quiz 2 is 7%.

These findings may indicate that use of the M-Learning MOD over time has a positive impact on quiz performance. By the time Quiz 2 was taken, both study groups had an opportunity to use the M-Learning MOD; the Control group for 1 week, the Treatment group for 2 weeks. Findings are discussed further in chapter 5.

4.4.6.13 H6c

Table 4.27. Summary of Hypotheses Testing – H6c.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H6c	The effect of Use Behavior between Time 2 and Time 3 (UB T2-T3) on Quiz 2 Performance (PERF Q2) will be moderated by Mode of Delivery (MOD).	Not Supported	PERF Q2	UB T2-T3	MOD	0.418

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

MOD did not significantly moderate the relationship between UB T2-T3 and PERF Q2. UB T2-T3 takes into account M-Learning MOD behavior after both groups used the system between week 1 and week 2.

The direct effect of MOD on PERF in this hypothesis was significant and similar to that seen in H6b (p=.011; Adjusted R^2 =.055). Varied use of delivery modes, therefore, still seems to significantly impact quiz performance.

4.4.6.14 H6d

Table 4.28. Summary of Hypotheses Testing – H6d.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H6d	The effect of Use Behavior between T1 and T3 (UB) on Average Performance over Quiz 1 and Quiz 2 (AVG PERF) will be moderated by Mode of Delivery (MOD).	Not Supported	AVG PERF	UB	MOD	0.996

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

The interaction between UB and AVG PERF was not moderated by MOD. The direct effect of MOD on PERF in this hypothesis was significant and similar to that seen in H6b (p=.011; Adjusted R^2 =.055). Varied use of delivery modes, therefore, still seems to account for a significant amount of the variance in quiz scores.

4.4.6.15 H6e

Table 4.29. Summary of Hypotheses Testing – H6e.

Hypothesis	Description	Conclusion	DV	IV	Moderators	Significance[1]
H6e	The effect of Use Behavior (UB) on the difference between Performance on Quiz 1 and Quiz 2 [(PERF (Q2-Q1)] will be moderated by Mode of Delivery (MOD).	Not Supported	PERF (Q2-Q1)	UB	MOD	0.607

Source: Investigator.

1. *p<.05; **p<.01; ***p<.001

The effect of MOD on PERF (Q2-Q1) was not moderated by MOD. The direct effect of MOD on PERF in this hypothesis was significant (p=.002; Adjusted R^2=.081. The R^2 shows that an even greater amount of variance in quiz scores is attributable to MOD in this hypothesis versus that seen in H6b, H4c, and H6d.

Chapter 5 Conclusions and Future Research

5.1 Conclusions

Participants in the Control group (Face-to-Face) outperformed Treatment group participants (M-Learning) on both quizzes. Face-to-Face participants performed significantly better (9 %) in average performance on Quiz 1 than the M-Learning Mode of Delivery participants (p=.000; Adjusted R^2 =.106). Similarly, Face-to-Face participants significantly outperformed M-Learning Mode of Delivery participants by 7% on Quiz 2 (p=.010; Adjusted R^2=.052). The average increase in performance across both quizzes was 8%.

Other than mode of delivery, the factors that influenced the acceptance and use of M-Learning were not determined; the Unified Theory of Acceptance and Use of Technology Model (UTAUT)[257], adapted specifically to measure M-Learning acceptance, did not provide as much insight into the M-Learning environment as it had when applied to other technology contexts.

A detailed overview of study outcomes is provided in section 5.4.

5.2 Dissertation Review

Sections 5.2.1 - 5.2.3 provide a brief summary of the dissertation.

257. Venkatesh, et al. “User Acceptance of Information Technology”.

5.2.1 Chapter 1

Chapter 1 provided an introduction to the study. The purpose of the study was stated: 1) to assess Mobile Learning (M-Learning) effectiveness vis-à-vis Face-to-Face Learning, and 2) to assess the extent to which students accept M-Learning.

The chapter identified gaps in the pedagogical Media Comparison Study literature and defined the contributions this study would make.[258] M-Learning was defined as a subset of Electronic Learning (E-Learning) which in turn was identified as a subset of Distance Learning (D-Learning). All three learning delivery methods were shown to rest upon the foundation of Face-to-Face learning. The M-Learning paradigm was defined as, 'Anytime, Anywhere' learning.[259]

Three beneficiaries of the study were identified:

1. Instructors in schools and post-secondary institutions
2. Trainers in private industry
3. The workforces in general.

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258. "In these studies, researchers look to compare student outcomes for two courses that are delivered through two different methods, thereby identifying the "superior" method for teaching effectiveness." WCET, the Cooperative Advancing the Effective use of Technology in Higher Education, "Frequently Asked Questions," under "What is the "No Significant Difference Phenomenon?" http://nosignificantdifference.wcet.info/faq.asp#Q7 (accessed February 25, 2008).

259. Cobcroft, Towers, Smith, and Bruns, "Literature Review"; Emily Hollis, "M-Learning; The Next Wave for Training and Development," *Chief Learning Officer*, March 2004, http://www.clomedia.com/content/templates/clo_article.asp?articleid=429&zoneid=101 (accessed August 30, 2007); Ellen Wagner, "Mobile Learning: The Next Step in Technology-Mediated Learning," *Chief Learning Officer*, February 2007, under "The Changing Nature of Learning," http://www.clomedia.com/content/templates/clo_article.asp?articleid=1686&zoneid=77 (accessed August 28, 2007).

The methodology used to address the first research question is a Performance Model implemented in a Media Comparison Study. The methodology used to address the second research question is the adapted UTAUT model – adapted to incorporate Mode of Delivery as an additional moderating variable and Performance as an outcome variable. Age was considered relatively homogenous across the study and was excluded as a moderator from the applied UTAUT model.

5.2.2 Chapter 2

Chapter 2 identified and defined the 8 underlying information systems acceptance testing models synthesized into UTAUT. The models are rooted in IS, psychology, and sociology.

1. Theory of Reasoned Action (TRA)

2. Technology Acceptance Models
   a. Technology Acceptance Model (TAM)
   b. Technology Acceptance Model 2 (TAM2)

3. Motivational Model (MM)

4. Planned Behavior Theories (TPB, DTPB, C-TAM-TPB)
   a. Theory of Planned Behavior (TPB)
   b. Decomposed Theory of Planned Behavior (DTPB)

5. Combined Technology and Acceptance Model and Theory of Planned Behavior (C-TAM-TPB)

6. Model of PC Utilization

7. Innovation Diffusion Theory

8. Social Cognitive Theory

Researchers, in their attempts to prove IS acceptance, have historically 'picked and chosen' across the models or have taken all constructs from a 'favorite model'.[260] Venkatesh, et al. identified issues with these approaches as researchers ". . . ignore[ed] the contributions from alternative models". [261]

As a specialized education broadcast platform, M-Learning was shown to accept input in the form of learning content and then transmit, or make available, this content to a broad array of consumer devices: small information appliances (PDAs, smartphones, cell phones, etc.), small-form computers (laptop/notebook computers, etc.), and large-form devices (PCs, televisions, etc.).

M-Learning as an information mediator and education platform was shown to be output independent and thus unique in its ability to process a number of permutations and combinations of multimedia input and output. In addition, accessing and delivering M-Learning content was shown to be an important factor in the mainstream adoption of the platform

5.2.3 Chapter 3

Chapter 3 is a detailed overview of the two research models – UTAUT and the Media Comparison Study. Study procedures were provided, as was an overview of the research approach.

260. Venkatesh, et al. "User Acceptance of Information Technology", 426.

261. Ibid.

Fifteen hypotheses were presented and defined. Each of the 9 hypotheses presented in the UTAUT model were used. 6 additional hypotheses designed to capture the effect of Mode of Delivery and Performance were incorporated.

Study instrumentation was introduced to include: 1) a pseudonym assignment document, 2) a demographics questionnaire, 3) two quizzes, 4) the UTAUT survey, and 5) an M-Learning Mode of Delivery Use Log. Study procedures were provided, as was the data collection method.

Validity concerns were addressed and a detailed approach to the methods which would eventually be employed to test UTAUT and Performance model validity was introduced. Finally, the methods used to test hypotheses were discussed.

5.3 Problem Statement

The purpose of this study was to assess the effectiveness of the M-Learning mode of education delivery vis-à-vis Face-to-Face delivery. The study was also designed to determine the extent to which students accepted the M-Learning education delivery approach.

A gap exists in the body of pedagogical literature regarding M-Learning; over the past 70 years, numerous studies have been conducted that compare alternate modes of education delivery to Face-to-Face delivery.[262] There remains a dearth, however, of

262. Russell, *The No Significant Difference Phenomenon*.

media comparison studies that compare the M-Learning mode of education delivery to Face-to-Face delivery.[263]

This study was important because it addressed this gap through a comparison of the effectiveness of M-Learning versus Face-to-Face delivery. The study also contributed to the body of literature that has examined user acceptance of M-Learning.

5.3.1 Research Question 1

1. Is the M-Learning Mode of Delivery more or less effective than Face-to-Face delivery?

As a result of the performance of participants on Quiz 1 and Quiz 2, the M-Learning mode of education delivery was found to be significantly *less effective* than Face-to-Face delivery in an academic setting. This conclusion was supported by the results of hypotheses H6a and H6b (see figure 5.1, figure 5.2).

263. Barbara B. Lockee, John K. Burton, and Lawrence H. Cross, "No Comparison: Distance Education Finds a New Use for 'No Significant Difference'", *Educational Technology, Research and Development* 47, no. 3 (1999): 465-471*;* Russell, *The No Significant Difference Phenomenon*.

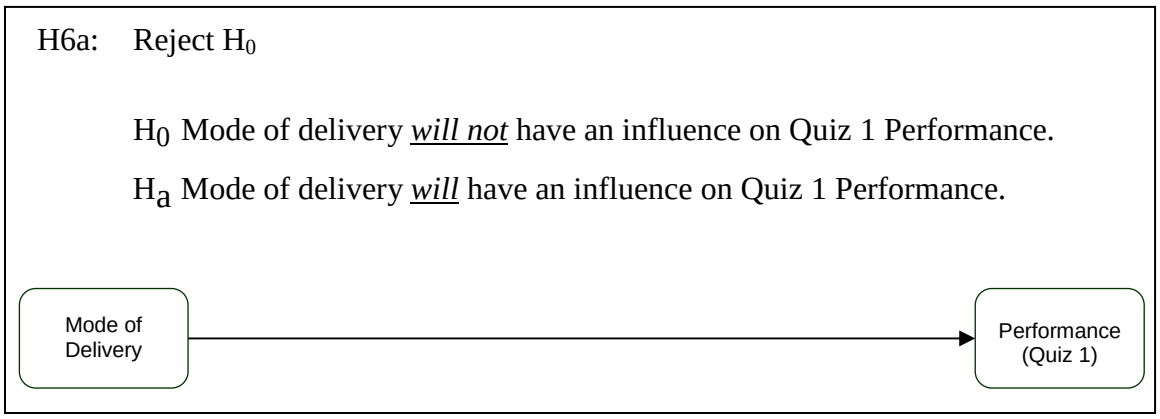

Figure 5.1. Performance Model Hypothesis H6a: Quiz 1 Performance. *Source*: Investigator.

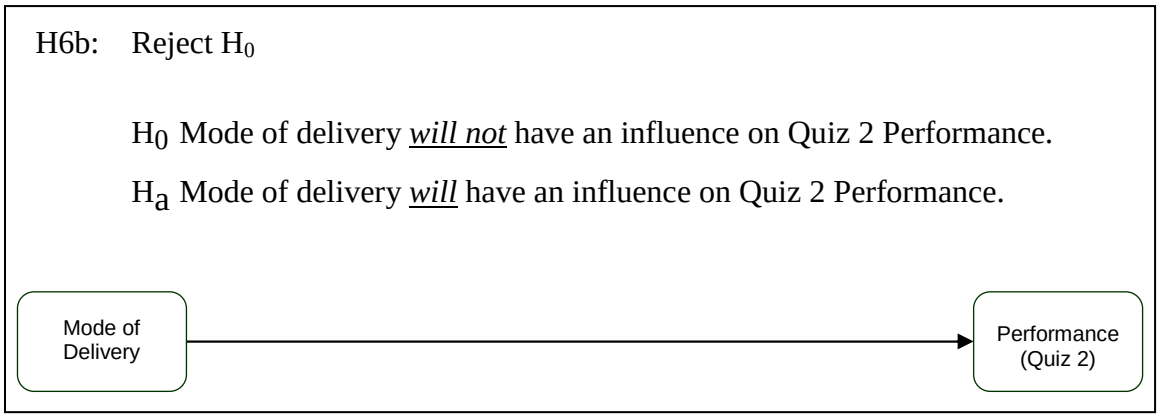

Figure 5.2. Performance Model Hypothesis H6b: Quiz 2 Performance. *Source*: Investigator.

5.3.2 Research Question 2

Research question 2 was defined as:

2. What are the factors that influence the acceptance and use of M-Learning?

The factors outside of Mode of Delivery *did not* impact the UTAUT outcome variables Behavioral Intention and Use Behavior; there was no significant support for any UTAUT hypotheses.

5.4 Results

In the M-Learning environment the Performance model captured Mode of Delivery effectiveness (see sections 5.4.1 and 5.4.2). The adapted UTAUT model, however, was less effective in measuring acceptance in the M-Learning environment than demonstrated in other contexts.

5.4.1 Quiz 1

The average Face-to-Face Quiz 1 score was 65%. The average M-Learning Quiz 1 score was 56%; the difference between the two study populations was 9%. The effect of Mode of Delivery on these quiz scores was significant at p=0.000; adjusted R^2=.106 (see table 5.1, figure 5.3).

Table 5.1. Quiz 1 Results.

Mode of Delivery	*N*	Mean	Std. Deviation
FTF	57	.6491	.08582
M-Learning	51	.5627	.15161

Source: Investigator.

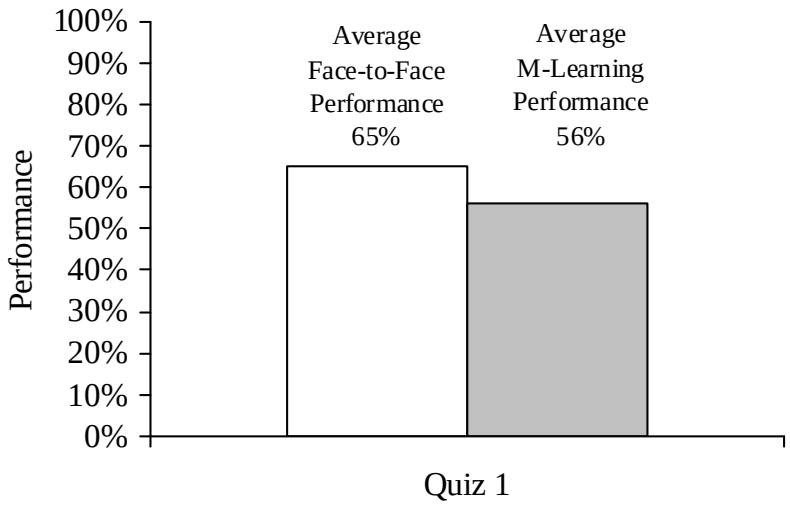

Figure 5.3. Average FTF, M-Learning Performance – Quiz 1. *Source:* Investigator.

5.4.2 Quiz 2

The average Face-to-Face Quiz 2 score was 66%. The average M-Learning Quiz 2 score was 59%; the difference between the two study populations was 7%. The effect of Mode of Delivery on these quiz scores was significant at p=.010, Adjusted R^2= .052 (see table 5.2, figure 5.4).

Table 5.2. Quiz 2 Results.

Mode of Delivery	*N*	Mean	Std. Deviation
FTF	57	.6579	.12635
M-Learning	51	.5873	.15357

Source: Investigator.

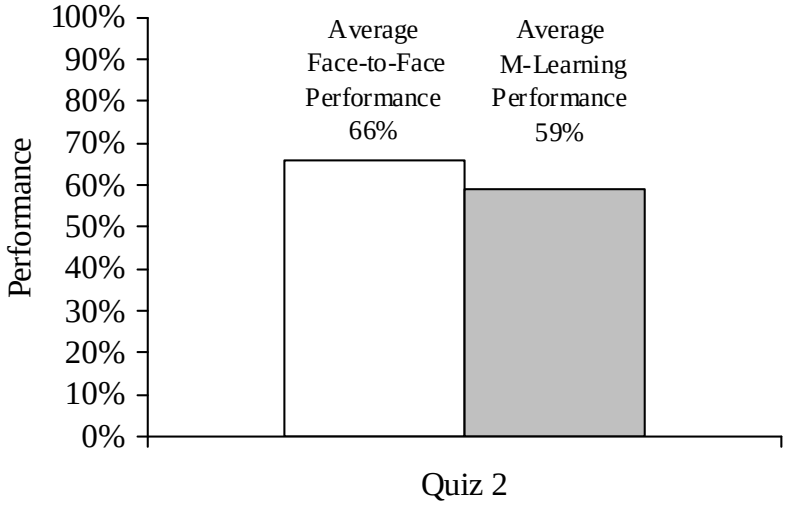

Figure 5.4. Average FTF, M-Learning Performance – Quiz 2. *Source:* Investigator.

5.5 Discussion

The difference between Quiz 1 scores was 9% (R^2 = .106); the difference between Quiz 2 scores was 7% (R^2 = .052) (see figure 5.5).

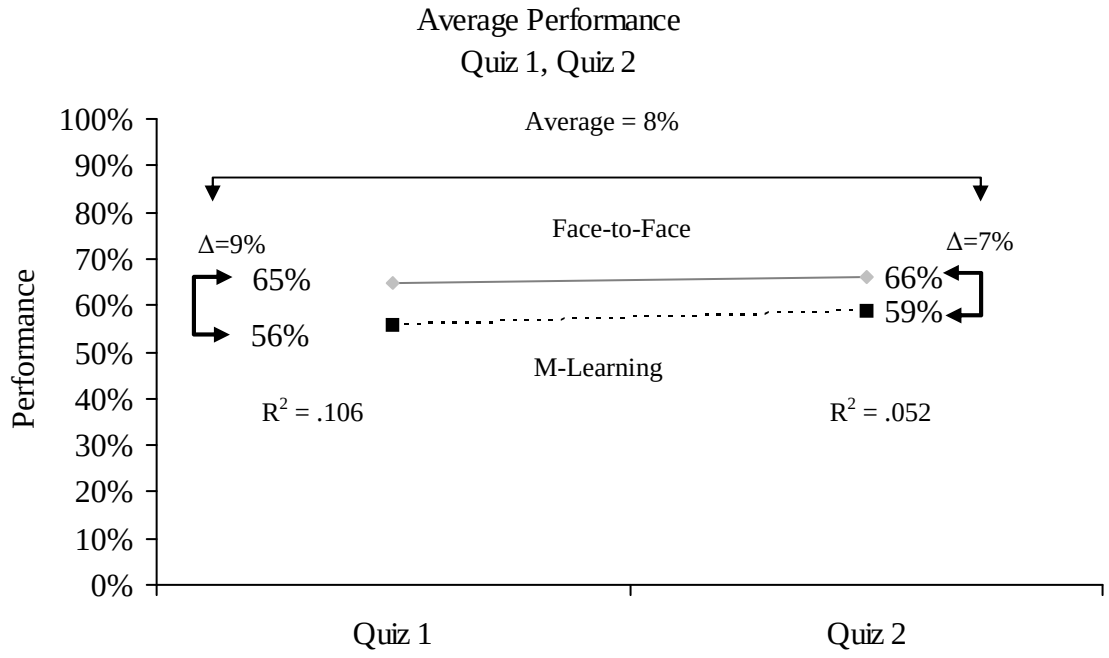

Figure 5.5. Average Performance: Quiz 1, Quiz 2. *Source*: Investigator.

In a real life context, depending upon the weight associated with each quiz, the impact of using a particular mode of delivery could mean the difference between a student earning one letter grade over another (Quiz 1= 9%, Quiz 2=7%). In turn, this could have an impact on a student's final grade for a course, which might then impact a student's overall grade point average (GPA).

Although the % change in performance of Face-to-Face participants across both quizzes was less than that of the M-Learning Mode of Delivery participants (1.5%, 5.4%, respectively), the Face-to-Face participants still performed significantly better than M-Learning Mode of Delivery participants on both quizzes.

The Face-to-Face group, with exposure to both the Face-to-Face *and* M-Learning modes of delivery, may have gained an advantage through a 'blended' learning approach; a learning approach that "combines . . . face-to-face approaches with the help of new information and communication media".[264]

The value of the blended approach, shown to be higher than the value of the M-Learning Mode of Delivery alone, might be capitalized upon by providing the M-Learning content to Face-to-Face students as a supplement to their traditional classroom activities. Under this blended scenario, the M-Learning Mode of Delivery would be made available to students upon conclusion of a traditional Face-to-Face lecture. Students could then access the M-Learning Mode of Delivery after class, listening to anytime, anywhere.

264. Thyssenkrup Steel, "Glossary," under, "Blended Learning," http://www.thyssenkrupp-steel.com/nachhaltigkeitsbericht2004_2005/en/service/glossar.jsp (accessed October 1, 2008).

5.6 Importance of the Findings

To establish the effectiveness of M-Learning, a Performance model may be desirable instead of a Use and Acceptance model. Capturing Use data through the M-Learning Mode of Delivery Use Log seemed to provide an adequate means of establishing Use Behavior patterns. The results therein showed that the Face-to-Face group, over the course of the study, used the M-Learning Mode of Delivery .98 times, while the M-Learning group used the M-Learning Mode of Delivery 2.02 times. A difference in usage is expected; the M-Learning Mode of Delivery population had access to the material for a longer period of time.

The Use Behavior statistics gleaned from the Performance Model indicate that, on average, a student will use the M-Learning of Delivery once per week, regardless of whether they receive a Face-to-Face lecture or are exposed to M-Learning alone.

In summary, research contributions include the ability to demonstrate to stakeholders that effectiveness and use can be measured through a model with few variables. Additionally, the study demonstrated that an esoteric, technical topic can be taught across delivery modes.

5.6.1 Importance for Education

As the study demonstrated, the Media Comparison Study can take as little as two weeks (with three contact points) to administer and analyze. Whether the results support or negate à priori predictions of Performance and Use, little time need be invested in the process which leads to Media Comparison Studies as inexpensive means of analysis.

Quizzes are consistent with traditional Face-to-Face instruments and can be incorporated into existing learning outcomes and objectives.

Exceptions to traditional Face-to-Face learning outcomes and objectives include deployment of the demographics survey, UTAUT survey, and M-Learning Mode of Delivery Use Log. However, even with these non-traditional methods incorporated into a standard syllabus, they are non-disruptive and take little time to administer.

5.6.2 Importance for Educators

The literature reveal that few, if any, educators have conducted M-Learning Media Comparison Studies. A desirable outcome of this study would be that researchers are encouraged to conduct similar studies and adapt M-Learning technologies accordingly.

Whether the new technology is a classroom multimedia-automation suite, a method for creating electronic versions of course materials to be hosted on a content-management system, e.g. Blackboard, or an implementation of iTunes University, educators may find that a Media Comparison Study model can be used to assist in the assessment processes with little effort and expense.

Using M-Learning in *support* of traditional Face-to-Face lectures in the classroom may prove to be more valuable than using M-Learning to *supplant* Face-to-Face lectures. There was a significant increase in average Face-to-Face group quiz performance (thes students had both Face-to-Face *and* M-Learning access) – 8% better than the Treatment group which only had access to the M-Learning Mode of Delivery.

This difference in effectiveness between the Face-to-Face and M-Learning populations might be attributable to the initial exposure of Face-to-Face students to a live lecturer in a traditional classroom. This presents Face-to-Face students with a familiar environment and might prove to be an advantage over M-Learning students who never receive Face-to-Face instruction.

5.6.3 Importance for Practitioners

One area of importance for practitioners is an increased understanding of the cost of training. This research may provide insight into whether it is cost effective to draw together employees from across the globe to a single location for a number of days to attend Face-to-Face training. As travel costs increase, practitioners may be inclined to distribute multimedia training in an M-Learning format in lieu of hosting traditional Face-to-Face training sessions. The question this study may help to answer is whether the M-Learning format,, the more cost-effective option, appears to be as effective or more effective than the traditional training sessions.

On its face, the ease of distributing M-Learning training materials to an organization's employees may appear attractive to employers. The total cost of ownership of the M-Learning Mode of Delivery (multimedia hosting, delivery, etc.) pales in light of the lodging, travel, and opportunity costs peculiar to the Face-to-Face delivery approach. In light of this study, however, practitioners might weigh costs against effectiveness; the Face-to-Face mode of delivery was demonstrated to be significantly more effective (8%) than the M-Learning mode of delivery.

5.7 Contribution to the Literature

This research contributes to the body of andragogical, Media Comparison Study, No Significance Difference, and Technology Acceptance and Use literature.

- Andragogical Literature

  The study focused on adult learners; those who "learn differently from young people . . . and whose reasons for learning are different."[265] At the time of this research, the study population comprised digital natives – those who grew up with digital technology such as computers, the Internet, mobile phones and MP3s – basically, anyone under the age of 28.[266]

  Of interest is that the digital native M-Learning Mode of Delivery participants, supposedly comfortable and experienced with MP3 technology, did not fare as well as their Face-to-Face colleagues when audio technology was their only means of quiz preparation.

  This could be the result of a phenomenon where students, although raised in a high-tech culture, continue to be instructed in, and are familiar and comfortable with, the Face-to-Face education environment. It is interesting that this scenario exists even in the face of the constant introduction of an ever-growing array of new technologies.

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265. San Diego State University, "Encyclopedia of Educational Technology," under "Andragogy: Teaching Adults," http://coe.sdsu.edu/eet/Articles/andragogy/index.htm (accessed November 3, 2008).

266. Prensky, "Digital Natives, Digital Immigrants".

A primary contribution to the andragogical literature is the discovery that digital natives, working in an environment that accommodates their rich history of technology use, performed at a significantly lower rate than other digital natives learning in a traditional environment.

- Media Comparison Studies

In this study, the Media Comparison Study methodology was demonstrated to be an effective means to compare one learning delivery method against another. Across two media, content was controlled while delivery was manipulated. Measuring student outcomes on two quizzes in this scenario provided hypothesis testing results significant enough to prove the efficacy of one delivery medium over another.

As a model, the Media Comparison Study is not difficult to design or employ. This may be seen as a limitation because one delivery method and another are compared only on the basis of performance. Additionally, it could be argued that in real life any number of moderators and/or mediators intervene between the single predictor and outcome variables inherent in the traditional Media Comparison Study model. For this reason the Media Comparison Study model may be perceived as weak, or even flawed.

In this implementation the Unified Theory of Acceptance and Use of Technology (UTAUT) model was adapted to include media and performance variables. Study results provided insight into comparisons of Face-to-Face and

M-Learning modes of delivery vis-à-vis quiz performance, but did not support the use of the UTAUT model in the education environment.

- No Significant Difference

The study concluded with a finding of significant performance differences on two quizzes between those participants assigned to the Control group (Face-to-Face) and those assigned to the Treatment group (M-Learning). Over a period of 70 years prior to the 2001 publication of his book, "The No Significant Difference Phenomenon," Russell documented hundreds (some say thousands) of Media Comparison Studies that found *no* Significant Difference between alternate education delivery methods.

Although the studies mostly resulted in No Significant Difference, Russell wondered why the research had been, "Largely ignored and disputed by three generations of educators and media specialists."[267] Russell's research led him to the conclusion that, ". . . no matter who or what is being taught, more than one medium will produce adequate learning results and we must choose the less expensive media or waste limited educational resources".[268]

As a demonstration of a Media Comparison Study that *found* a Significant Difference between alternate education delivery methods, this research contributes to the body of No Significant Difference literature and provides justification for taking a least expensive media approach *without*

267. Russell, *The No Significant Difference Phenomenon*, viii.

268. Ibid.

speculation as to the outcome. The study provided results that indicate M-Learning is not as effective as Face-to-Face learning. Thus, although not the least expensive option of the two alternatives, Face-to-Face students demonstrated significantly better performance than M-Learning Mode of Delivery students. Thus, this study supports the belief that the Face-to-Face delivery method should be deployed in post-secondary education institutions.

To further contribute to the No Significant Difference literature, continued research into M-Learning should be conducted across a range of disciplines, environments, and participants in order to provide continued perspectives into the effectiveness of Face-to-Face learning. These studies might focus on new learning delivery modes as they mature, using procedures similar to those undertaken here.

- Technology Use and Acceptance

The Unified Theory of Use and Acceptance of Technology (UTAUT) model proved ineffective in measuring the use of the M-Learning Mode of Delivery. UTAUT is a synthesis of eight underlying technology use and acceptance models and, as such, is considered the 'best of breed' approach to the measurement of use and acceptance.

As applied across a range of non-educational disciplines, Venkatesh, et al.'s studies found significant results that led them to a better understanding of the use behavior of technology end-users. This study did not find significant

support for the application of the UTAUT model in the M-Learning environment.

These results may pave the way for future research into M-Learning use and acceptance using alternate models, e.g. the Technology Acceptance Model.

5.8 Generalizability of the Findings

The findings of the Performance model are generalizable because, as an implementation of a Media Comparison Study, it was executed according to the recommended literature.[269] To further extend the generalizability of the findings in future research endeavors, researchers may wish to replicate the Media Comparison Study, but eliminate the Mode of Delivery moderator from the UTAUT model. This would ensure that the UTAUT model is applied as originally defined by Venkatesh, et al.

In summary, UTAUT may not have been a suitable model for this study. The incorporation of a Media Comparison Study within UTAUT may have caused the disparity of hypothesis-testing results noted between the original and adapted model.

5.9 Directions of Future Research

Future research might consider the incorporation of a learning style inventory prior to embarking on an M-Learning mode of delivery study. This study focused on providing participants with access to an MP3 audio file replica of the Face-to-Face lecture. It is possible that not all students work as well with audio as they might with

269. Russell, *The No Significant Difference Phenomenon*.

other media, e.g. video. Video might reinforce the learning process, especially if the video focuses on content and not the lecturer, e.g. PowerPoint slides, and movie clips versus footage of the instructor. In short, it might be the case that not only is the media itself important, but also the mode of delivery.

Future research might also focus on bandwidth issues. The M-Learning Mode of Delivery lecture was delivered over a period of 20 to 25 minutes (depending on the Investigator's rate of speech, and other common delivery nuances). The size of the MP3 file created from the lecture was 13MB.

Studying for a quiz after using the M-Learning Mode of Delivery requires a tremendous amount of self-discipline. Students may wait until the final few minutes before a scheduled quiz before they listen to a lecture(s) – if at all. This is in contrast to what occurs in the traditional classroom where students are exposed to at least one iteration of the lecture. Even if they choose to wait until the last minute to study for a quiz, they at least have the advantage of being exposed to the material in the classroom. Perhaps the lack of a controlled environment for M-Learning Mode of Delivery students caused a disadvantage.

Using the M-Learning Mode of Delivery *in conjunction with* Face-to-Face lectures may be most effective. Future Media Comparison Studies could be conducted to validate this possibility.

5.10 Limitations of the Study

In order to maintain parity across sections, Control group (Face-to-Face) participants were not allowed to ask questions during the Face-to-Face lecture. If questions were introduced to the Face-to-Face lecture, both the Control and Treatment (M-Learning) groups may have benefitted.

The demographics questionnaire revealed a relatively homogenous population, e.g. 87% of respondents were freshmen or sophomores, indicating an age difference of one year. This lack of heterogeneity was taken into consideration when the Age moderator was removed from the study UTAUT model.

Venkatesh, et al. performed four studies in their validation of the UTAUT model. Each study was performed in a unique workplace environment: product development, sales, business account management, and accounting.[270] Additionally, Venkatesh, et al. tested their model across four distinct technologies: an online meeting manager, database application, portfolio analyzer, and accounting system.[271] It is hypothesized that these varied workplaces and technologies provided a pool of participants more heterogeneous in nature than that encountered in this study.

The Investigator had no control over the type of devices used by participants to access the M-Learning Mode of Delivery audio file. The type of device used was important because the intent was to measure the effectiveness and acceptance of M-Learning, as opposed to Distance or Electronic learning. The device type used to access

270. Venkatesh, et al. "User Acceptance of Information Technology", 437.

271. Ibid.

the MP3 was self-reported. These data were not, however, used to discriminate whether a participant was eligible to be included in study analyses. The desirable devices included PDAs, MP3 players, portable game devices, handhelds, tablets, and laptops. Actual devices used included traditional D- and E-Learning devices such as desktop computers, etc.

This longitudinal study tracked the activities, and measured the performance of, participants over a two-week period. This time period included three contact points. The study length was short relative to a traditional 15-week semester. The results of this study may have differed if the observation period was lengthened to include more contact points and additional opportunities for students to demonstrate their proficiency in the subject matter were added.

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Appendices

Appendix 1: Significant M-Learning Milestones

Source: Investigator

1728: Caleb Phillipps, Teacher of the 'New Method of Short Hand' advertises in The Boston Gazette (March 20):

> . . . any Persons in the Country desirous to Learn this Art [short hand], may by having the several Lessons sent weekly to them, be as perfectly instructed as those that live in Boston.[272]

1833: In '*Lunds Weckoblad*', No.30, 1833, a weekly published in the Swedish university city of Lund, an offer appears for Ladies and Gentlemen to gain, ". . . an opportunity to study Composition through the medium of the Post."[273]

1840s: Sir Isaac Pitman takes advantage of England's new Penny Post system to launch a shorthand correspondence course.

1923 - 1927: Television is invented: Vladimir Kosma Zworykin (Westinghouse patent 1923)/ Philo Taylor Farnsworth (transmission of signals – 1927).[274]

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272. Caleb Phillips, quoted in Börje Holmberg, "The Evolution of the Character of Practice of Distance Education," *Open Learning* (1995): 47-53.

273. J.A. Baath, *Postal Two-Way Communication in Correspondence Education* (Lund: Gleerup, 1980) quoted in Börje Holmberg, "The Evolution of the Character of Practice of Distance Education," *Open Learning* (1995): 47-53.

274. Physlink.com, "Who is the Inventor of Television?"

1926: The British Broadcasting System (BBC) puts forth the idea of a 'Wireless University':[275]

R. C. G. Williams of the Institution of Electrical Engineers argued for a 'teleuniversity', which would combine broadcast lectures with correspondence texts and visits to conventional universities - a genuinely 'multi-media' concept.[276] This also represents one of the first instances of 'blended learning' : . . . training which combine[s] different activities including on-site classes, real-time e-learning sessions and independent learning.[277]

1969: Idea of the BBC "Open University" (OU) announced; British Prime Minister Iain Macleod describes it as, "Blithering nonsense."[278]

1970: Kay's Dynabook proposal.

1970: The first student applications for the OU.[279]

1973: Continued development of small information appliances relied upon by M-Learning initiatives: Cellular Telephone (Motorola): 1973[280]

1993: Continued Development of small information appliances relied upon by M-Learning initiatives: Newton (Apple) PDA[281].

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275. The Open University, under "Is the Open University a Real University?"

276. Ibid.

277. CrossKnowledge, "Glossary," under "Blended Learning," http://corp.crossknowledge.com/NET/en/document/eng/top_menu/solutions/glossary/index.htm (accessed October 19, 2007).

278. The Open University, under "Is the Open University a Real University?"

279. Ibid., under "The First Student Applications: 1970".

280. Mary Bellis, "Selling the Cell Phone," About.com: Inventors, http://inventors.about.com/library/weekly/aa070899.htm (accessed October 23, 2007).

The use of videoconferencing, interactive TV, FAX, and satellite[282] by such institutions as the OU leads toward the commercialization of electronic D-Learning; D-Learning becomes synonymous with E-Learning.

The first PDAs are released.[283]

1996: ASTD conference, where a single workshop devoted to "Intranet-based training" was mobbed by more than 500 participants. The one-hour session led directly to a series of articles, speeches, million dollar contracts and an unknown number of additional idea viruses.[284]

1997: Peter Drucker, in a Forbes Magazine interview states:

> Already we are beginning to deliver more lectures and classes off campus via satellite or two-way video at a fraction of the cost. The college won't survive as a residential institution. Today's buildings are hopelessly unsuited and totally unneeded. [285]

2001: The M-Learning research and development project – funded by the European Commission and the (England) Learning and Skills Council – is considered:

> . . . highly innovative and unusual . . . few people knew about the concept

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281. Leander Kahney, "Apple's Newton Just Won't Drop," *Wired*, http://www.wired.com/gadgets/mac/commentary/cultofmac/2002/08/54580 (accessed October 23, 2007).

282. Kaplan Leiserson, "Learning Circuits: ASTD's Source for E-Learning".

283. About.com, "History of Laptop Computers".

284. Kruse, "The State of E-Learning".

285. Robert Lenzer, and Stephen S. Johnson, "Seeing Things as they Really Are," *Forbes*, March 10, 1997, 122-128.

of mobile learning, or, indeed, could envisage the potential of mobile devices for learning.[286]

2004: Though the term [M-Learning] itself has been around *for a few years now* [emphasis added], it is only recently that the reality has begun to catch up to the hype as with the introduction of smaller and more powerful computer devices (e.g., Pocket PCs, Tablet PCs, web-enabled phones) and the rapid spread of wireless access points (Bluetooth, Wi-Fi and 3G). Advice to CLOs: [Chief Learning Officers] invest $150 and 4 hours on a Saturday to install a Wi-Fi network in your home; see how it changes how you use the Internet.[287]

M-Learning research and development project completes three years of work.[288]

2005: One can see many parallels between the history of distance education and the history of mobile learning. Mobile learning is still in the period of criticism, of lack of acceptance, of lack of status, of lack of certification for its degrees, diplomas and training certificates that characterized the first 100 years of distance education [1870 – 1970].[289]

2006: M-Learning has now emerged as a *new wave of development* [emphasis added], based on the use of mobile devices combined with wireless infrastructure.[290]

2006: Symbian, developer of the first smartphone, announces that it has shipped 100 million smartphones to over 250 network operators worldwide since its formation.

However, we are still at the beginning of a technology revolution that will change peoples' lives profoundly.[291]

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286. Jim Attewell, "Mobile Technologies and Learning," Learning Skills and Development Agency, under "Preface," http://www.m-learning.org/docs/The%20m-learning%20project%20-%20technology%20update%20and%20project%20summary.pdf (accessed October 24, 2007)

287. Kevin Kruse, "What Will 2004 Bring?" e-LearningGuru.com, under "M-Learning (i.e., Mobile Learning)," http://www.e-learningguru.com/articles/art_misc_4.htm (accessed September 21, 2007).

288. Attewell, "Mobile Technologies," 1.

289. Desmond Keegan, "The Incorporation of Mobile Learning into Mainstream Education and Training," under "Parallels Between Distance Education and Mobile Learning," http://www.mlearn.org.za/CD/papers/keegan1.pdf (accessed September 21, 2007).

290. Upadhyay, "M-Learning".

2007: iPods and PDAs are recognized as part of the M-Learning mix, but mobile phones were chosen as the first entry point as almost every student has one. As mLearning technology converges, we look forward to an affordable iPod and PDA device with mobile phone connectivity. To complement the mobile options, audio and video tracks are also made available to students for free, to download to their computer, and then transfer to their iPod or mobile phones via a USB cable or Bluetooth. [292]

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291. Symbian, "100 Million Symbian Smartphones Shipped," http://www.symbian.com/news/pr/2006/pr20068610.html (accessed October 23, 2007).

292. Peter Mellow, "mLearning and the Three Ps: iPods, PDAs and (mobile) Phones," http://edcommunity.apple.com/ali/story.php?itemID=742 (accessed October 26, 2007).

Appendix 2: UTAUT Models and Theories of Individual Acceptance

Model/Theory	Core Constructs	Definitions
Theory of Reasoned Action (TRA)	Attitude Toward Behavior	". . . an individual's positive or negative feelings (evaluative affect) about performing the target behavior."[293]
	Subjective Norm	". . . the person's perception that most people who are important to him think he should or should not perform the behavior in question."[294]
Technology Acceptance Model (TAM)	Perceived Usefulness	". . . the degree to which a person believes that using a particular system would enhance his or her job performance."[295]
	Perceived Ease of Use	". . . the degree to which a person believes that using a particular system would enhance his or her job performance."[296]

293. Fishbein and Ajzen, *Belief, Attitude, Intention, and* Behavior, 216.

294. Ibid., 302.

295. Fred D. Davis "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly* 13, no. 3 (September 1989): 320.

296. Ibid.

Model/Theory	Core Constructs	Definitions
	Subjective Norm	Adapted from TRA/TPB. Included in TAM2 only.
Motivational Model (MM)	Extrinsic Motivation	The perception that uses will want to perform and activity, ". . .because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions."[297]
	Intrinsic Motivation	The perception that users will want to perform an activity, ". . . for no apparent reinforcement other than the process of performing the activity per se."[298]
Theory of Planned Behavior (TPB)	Attitude Toward Behavior	Adapted from TRA
	Subjective Norm	Adapted from TRA
	Perceived Behavioral Control	". . . the perceived ease or difficulty of performing the behavior."[299] In the context of IS research, ". . . perceptions of internal and external constraints on behavior."[300]

297. Fred D. Davis, Richard P. Bagozzi and Paul R. Warshaw, "Extrinsic and Intrinsic Motivation to Use Computers in the Workplace," *Journal of Applied Social Psychology*, 22, no. 14 (July 1992): 1112.

298. Ibid.

299. Ajzen, "The Theory of Planned Behavior," 188.

300. Taylor and Todd, "Understanding Information Technology Usage," 149.

Model/Theory	Core Constructs	Definitions
Combined TAM and TPB (C-TAM-TPB)	Attitude Toward Behavior	Adapted from TRA/TPB
	Subjective Norm	Adapted from TRA/TPB
	Perceived Behavioral Control	Adapted from TRA/TPB
	Perceived Usefulness	Adapted from TAM
Model of PC Utilization (MPCU)	Job Fit	". . . the extent to which an individual believes that using [a technology] can enhance the performance of his or her job."[301]
	Complexity	Based on Rogers and Shoemaker,[302] ". . . the degree to which an innovation is perceived as relatively difficult to understand and use."[303]
	Long-term Consequences	"Outcomes that have a pay-off in the future."[304]

301. Thompson, Higgins, and Howell, "Personal Computing," 129.

302. Rogers and Shoemaker, Communication of Innovations.

303. Thompson, Higgins, and Howell, "Personal Computing," 128.

304. Ibid., 129.

Model/Theory	Core Constructs	Definitions
	Affect Toward Use	Based on Triandis,[305] affect toward use is "feelings of joy, elation, or pleasure, or depression, disgust, displeasure, or hate associated by and individual with a particular act."[306]
	Social Factors	Derived from Triandis,[307] social factors are, ". . . the individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations."[308]
	Facilitating Conditions	Objective factors in the environment that observers agree make an act easy to accomplish. For example, returning items purchased online is facilitated when no fee is charged to return the item. In and IS context, ". . . provision of support for users of PCs may be one type of facilitating condition that can influence system utilization."[309]

305. Triandis, Interpersonal Behavior.

306. Thompson, Higgins, and Howell, "Personal Computing," 127.

307. Triandis, Interpersonal Behavior.

308. Thompson, Higgins, and Howell, "Personal Computing," 126.

309. Ibid., 129.

Model/Theory	Core Constructs	Definitions
Innovation Diffusion Theory (IDT)	Relative Advantage	". . . the degree to which an innovation is perceived as being better than its precursor."[310]
	Ease of Use	". . . the degree to which an innovation is perceived as being difficult to use."[311]
	Image	"The degree to which use of an innovation is perceived to enhance one's image or status in one's social system."[312]
	Visibility	The degree to which one can see others using the system in the organization. (adapted from Moore and Benbasat)[313]
	Compatibility	". . . the degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters."[314]

310. Moore and Benbasat, "Development of an Instrument," 195.

311. Ibid., 195.

312. Ibid.

313. Ibid., 192-222.

314. Ibid., 195.

Model/Theory	Core Constructs	Definitions
	Results Demonstrability	". . . the tangibility of the results of using the innovation, including their observability and communicability."[315]
	Voluntariness of Use	". . . the degree to which use of the innovation is perceived as being voluntary, or of free will."[316]
Social Cognitive Theory (SCT)	Outcome Expectations – Performance	The performance-related consequences of the behavior. Specifically, performance expectations deal with job-related outcomes.[317]
	Outcome Expectations – Personal	The personal consequences of the behavior. Specifically, personal expectations deal with the individual esteem and sense of accomplishment.[318]
	Self-efficacy	Judgment of one's ability to use a technology (e.g., using a computer).[319]

315. Ibid., 203.

316. Ibid., 195.

317. Compeau and Higgins, "Computer Self-Efficacy," 145-198.

318. Ibid.

319. Ibid.

Model/Theory	Core Constructs	Definitions
	Affect	An individual's liking for a particular behavior (e.g., computer use).[320]
	Anxiety	Evoking anxious or emotional reactions when it comes to performing a behavior (e.g., using a computer).[321]

320. Ibid.

321. Ibid.

Appendix 3. M-Learning MOD Use Log

Directions: Please complete one row of this log each time you access or listen to the M-Learning Audio File. Circle your response or fill in the "Other" blank					
Where did you retrieve the file from?	**How did you connect to the file?**	**Where were you when you listened to the file?**	**On what device did you listen to the file?**	**When did you start to listen to the file?**	**For how long did you listen to the file?**
Blackboard Device I own Someone else's device Other: _____	Ethernet Cable DSL Wireless Directly to a playback device Other: _____	Home Outside Library Dormitory Other: _____	PC Laptop iPOD PDA Cell Phone Other: _____	Month (MM) : _____ Day: (DD): _____ _____ : _____ AM PM (circle one)	_____ Minutes
Where did you retrieve the file from?	**How did you connect to the file?**	**Where were you when you listened to the file?**	**On what device did you listen to the file?**	**When did you start to listen to the file?**	**For how long did you listen to the file?**
. . .	. . .	. . .	. . .	. . .	. . .

Source: Investigator.

Appendix 4: Introduction to Study

Source: Investigator.

1. Do not say Control or Treatment, say FTF or M-Learning
2. Say Quiz, not test or evaluation
3. They are Multiple-Choice quizzes
4. You will receive Individual Extra Credit, not group credit, even though the quizzes are the result of group work.
5. Regardless of your score across both tests, as long as it is >0, you will receive some extra credit. Not losing anything, you can only gain. Since you will be at lab anyway, it might be a good idea to participate.
6. There will be 3 contact times.
7. You must still have to go to lab because attendance is mandatory. The study will only take (at most) 30 minutes of lab per contact time.
8. Your Lecturer (state name) has approved this.
9. This is the last lecture you will receive. After your first quiz next week, you will have access to the lecture online in order to study for quiz two.
10. To be eligible for the Apple Store gift certificate *and* extra credit, you must participate in all study procedures – two quizzes, a survey, and one questionnaire.
11. You can take notes any way you wish – on the computer, on paper, etc.
12. Extra credit is on an individual basis – even though the gift certificate is awarded to the best performing student across both quizzes, each participant is eligible to receive extra credit regardless of the best aggregate score in class.
13. There will be two, 20 minute, 15 questions quizzes.

Appendix 5: IRB-Approved Study Procedures

Source: Host Post-Secondary Institution Internal Review Board.

OVERVIEW

The following study is voluntary. If you choose to participate you will be eligible to receive:

1. A maximum of 10 Extra Credit points to be applied to your final lecture project score (to be applied at the discretion of your lecturer)
2. A $100 gift certificate to the Apple Store.

NOTE: Participation in the study requires mandatory Lab attendance over a two week period to ensure that you participate in *all* study-related procedures.

DETAILS

You are invited to participate in a research study under the direction of [intentionally omitted] of the Department of Information Systems and Technology Management, School of Business, [location intentionally omitted], and paid for by [the Investigator – name intentionally omitted].

Taking part in this research is entirely voluntary. Your academic standing will not, in any way, be affected should you choose not to participate or if you decide to withdraw from the study at any time.

STUDY DESCRIPTION

The purpose of this study is to:

Evaluate the Effectiveness and Acceptance of Mobile Learning.

The research will be conducted at the School of Business, the [location intentionally omitted]. You will be one of approximately 250 participants asked to take part at this location.

If you choose to take part in this study, you may be asked to perform one or more of the following research activities over a three-week period:

1. Complete a 3-5 minute questionnaire during a regularly scheduled Lab.
2. Complete one 10 minute survey during a regularly scheduled Lab.

3. Attend one 15 minute lecture conducted during a regularly scheduled Lab.
4. Listen to and log your use of an electronic audio version (MP3) of the lecture.
5. Complete two 20-minute, 15-question quizzes based upon lecture content:
    a. Both quizzes will be administered during a regularly scheduled Lab. Your performance on both tests will be averaged. Your average score will be multiplied by the 10 eligible Extra Credit points to form your final Extra Credit point total.
    b. The student in each participating section with the highest average score across both tests will receive a $100 gift certificate to the Apple Store. In the case of a tie, a random drawing will be held to determine the gift certificate recipient.

Over the three-week period, it is anticipated that these research activities will require approximately two to three hours of your time.

RISKS

There are no physical risks associated with this study. There is, however, the possible risk of loss of confidentiality. Every effort will be made to keep your information confidential, however, this can not be guaranteed. Some of the questions we will ask you as part of this study may make you feel uncomfortable. You may refuse to answer any of the questions and you may take a break at any time during the study. You may stop your participation in this study at any time.

BENEFITS

Other than the opportunity to receive Extra Credit points and a $100 Apple Store gift certificate, you will not benefit directly from your participation in the study. The benefits to science and humankind that might result from this study are:

1. An increased understanding of the role mobile devices, e.g. PDAs, cellular telephones phones, portable music players, etc. play in higher education student performance.
2. A greater understanding of learning in an electronic, mobile environment versus learning in a traditional classroom, face-to-face environment.
3. An understanding of the acceptance of electronic, mobile learning by students.

PARTICIPATION

The investigator can decide to withdraw you from the study at any time. You could be taken off the study for reasons related solely to you (for example, not

following study-related directions from the Investigator) or because the entire study is stopped.

If results of this research study are reported in journals or at scientific meetings, the people who participated in this study will not be named or identified. GW will not release any information about your research involvement without your written permission, unless required by law.

FURTHER GUIDANCE

The Office of Human Research of [institution name intentionally omitted], at telephone number [telephone number intentionally omitted], can provide further information about your rights as a research participant. If you think you have been harmed in this study, please report this to the Principal Investigator of this study or call the Office of Human Research immediately.

Further information regarding this study may be obtained by contacting [Principal Investigator name intentionally omitted], Principal Investigator of the study at [telephone number intentionally omitted], [email address intentionally omitted]. Alternately, you may contact [Student Investigator/Research Coordinator name intentionally omitted] [telephone number intentionally omitted], the Student Investigator/Research Coordinator.

To ensure anonymity, your signature is not required on this document unless you prefer to sign it. Your willingness to participate in this research study is implied if you provide your first and last name on the pseudonym handout.

Please keep a copy of this document in case you want to read it again

Appendix 6: Pseudonym Assignment

Source: Investigator.

Your Pseudonym is:

C14772

Please keep this unique identifier in a safe place. If you lose this code, only your lab instructor will be able to retrieve it for you.

If you cannot retrieve this code, you will no longer be eligible to participate in the study.

C14772

Your First Name _____

Your Last Name _____

You are providing your name so that faculty members can match your name to your quiz scores.

Your name and Pseudonym *cannot* be used to track other facets of your participation in this study, i.e. no one will be able to match survey and questionnaire responses to you.

Appendix 7: FTF Lecture

Source: Investigator.

Data Warehouses are very large databases. In some implementations, they hold ***Petabytes*** of data. A petabyte is hard to imagine – as a unit of information of computer storage it is equal to one quadrillion bytes, or 2 to the 51st power!

Data Warehouses grow so large because they often do not comprise one database – imagine trying to stuff a petabyte of data into the sample databases you created here. They are capable of, and often do, hold thousands and sometimes MILLIONS of tables from databases across an enterprise.

Data warehouses have several common ways to relate tables to one another. One way is called the ***star schema***. As far as relationships go, a star schema has a single data table in the middle – referred to as a fact table. It contains transactions and is the largest table in the data warehouse. For example, the number of items a customer ordered, how much the item cost, and the total price of the order transaction.

The 'points' of the star are tables that contain information about the transactions. For instance, for a given item we can create a schema "point" or 'table', often referred to as a 'dimension' that holds a description of the item – where it was manufactured, its unique bar code, and other static, i.e. 'non volatile' information about the item. ***When I talk about 'non-volatile' I am referring to the fact that item descriptions and place of manufacture rarely change.*** For this example, let's assume that we have ten fields of non-volatile information pertaining to an item. I already discussed two – place of manufacture and bar code.

The unique bar code for the item is placed in the fact table as a key. Doing so means we don't have to store all of the item information related to a single transaction in the fact table over and over again each time for each transaction. Instead, we look at a row in the fact table, find out the bar code for the item, then look at the related Item dimension to get all of the specifics about the item related to the transaction.

If we stored all ten fields of the Item dimension in the fact table for every transaction and the fact table was filled with 10 million records, We would store ten, ten-byte fields of redundant or 100 bytes of data times 10 million records – a staggering amount of redundant, wasted data with the exception of the bar code.

And so we can build dimensions containing descriptions of records in the fact table, reducing the amount of data in the fact table. Soon, you have a schema that has the data table in the middle and a host of smaller tables surrounding it, all with a small unique key that points to each data table transaction.

The time dimension is a special and vital dimension of the data warehouse. It is probably the most important dimension in the star schema. The other dimensions afford the opportunity for the data warehouse to be ***subject-oriented*** **(Q1)** – organized around high level entities; grouped by subjects like item and store.

With the time dimension, we gain the ability to look at trends such as, "How many items were sold over the period January the 21st through February the 3rd", and, "What was the largest transaction in the month of May" – these questions are important because we can stretch them out in order to ask questions about, for example, periods of

time a promotion ran, good and bad days to sell items, and compare time periods this year to last year, etcetera.

The key used to tie the time dimension to the fact table is typically a ***Julian date*** – a unique pseudonym for a particular day in time. For instance the Julian date 2008001 represents January the 1st, 2008, and 2008365 represents December 31st, 2008 and so on. In this fashion, we can look at a transaction, determine its Julian Date, and then look at the matching record in the time dimension. By doing this, we can then look at the other fields for that Julian Date row in the time dimension in order to understand the Day, month, year, etc. that the Julian Date represents. As you can see, we don't have to store the entire date from the dimension in the fact table, just enough of it to make a small key. We can even make the time dimension fact table key represent hours and seconds!

The need for this type of data warehousing analysis was driven by business – ***businesses that needed an integrated view of company information***. **(Q3)**. As you might imagine, if a firm is downsizing, it does not need a data warehouse to figure out what is going on. ***If, however, the firm wants to focus on customer relationships, or supplier management***, a data warehouse is a great solution **(Q4)**. The data warehouse can combine information about customers, suppliers, and even systems that are usually not synchronized; For example, accounting with product management, sales with finance, and marketing with human resources.

But why aren't these entities already synchronized across the organization?

I mentioned before that data warehouses are often comprised of many smaller databases. Accounting might have a database, and Sales might have a database. In fact,

one day YOU might be creating a database for accounting or other segments, called "Stovepipes" within the organization.

When you do, will you travel to all of the areas of the firm to make sure that your database is consistent with other ones elsewhere in the firm, or will you work in a vacuum? Before you answer, consider today's global firms with thousands of employees, scattered geographically.

Without contacting other departments, you will have to define key concepts yourself. ***These definitions go into what is called a, 'data dictionary'***. Think about a simple definition that you might want to introduce into your accounting database – that of a 'Sale'. It sounds pretty straightforward. Your definition might be, "a sale is when a product is given to a customer for a price and the money is received".

The Sales Department, however, might have a different perspective. Since they work on commission, they don't want to wait to for money to roll in before they call a sale a sale. They want to call the sale a sale when a contract is signed. They work on commission and they want the sale to be recognized as quickly as possible. Sometimes, the process of getting money in after a contract is signed can take months, depending on the terms of sale – 30 days with no interest, 60 days with interest, a payment plan over years, etcetera. Accounting wants to recognize the sale then the money rolls in, while the sales rep wants to do it much sooner.

So, before we can even THINK about merging the sales and accounting databases into one and realize the value of the subsequent data warehouse that begins to be built,

we have to define key terms within the organization. ***Without doing so, the data will have discrepancies and become "Dirty".***

An outcome, then, of getting together a data warehouse to help us analyze the relationships between organizational stovepipes, customers, suppliers and other key relationships the firm has with the outside and also within its borders, is a better view of the firm's internal organization and well-defined, commonly accepted terms.

These common definitions are a byproduct of the need for a data warehouse while better security of data is a *driving* factor, as is the need to keep informational data with organizational data. This, combined with the fact that businesses ***need an integrated view of its information*** drive the data warehousing trend **(Q3.1)**.

As you build your small accounting database, you'll come to realize the value of having other company information inside it. Your operational accounting database, however, is not the place to begin storing all the information from across the enterprise. Data might be stored elsewhere in documents, spreadsheets, and a plethora of other formats. This will make it hard for you to gather it and store it. You will need help.

A large, enterprise-wide data repository such as a data warehouse created from your, and other operational databases around the firm, creates an informational data store that eliminates contention for resources that operational databases can't handle – for instance, running large, stovepipe-consolidating reports. Also, the data warehouse can contain massive amounts of data that your small database can't.

The mere process of loading the data warehouse with your and other departmental databases causes a cleaning and standardization of input data. ***This leads to quality and***

consistency. So we have several reasons to want an informational data store like a data warehouse, in addition to the operational data stores or, 'ODSes' such as yours found across the firm **(Q5)**.

As we consider rolling your ODS into the data warehouse, we consider your data as a 'data mart'. The difference between a data warehouse and a data mart is akin to the difference between Amazon and K-Mart. Amazon is a data warehouse – millions of products to sell from thousands of vendors, and K-Mart a much smaller entity with only thousands of products to sell per store. So, ***the data mart is like a data warehouse but limited in scope*** **(Q6)**.

Data marts were originally considered the foundation for data warehouses. Available throughout the firm, they were rolled up into the data warehouse in a process that extracted, cleansed, and loaded the data. Now, the process is run backwards: cross-departmental and single stovepipe data marts are ***filled exclusively from the enterprise data warehouse with clean, reconciled data*** **(Q7)**. Such data marts are ***integrated, subject-oriented, detailed databases designed to serve operational users*** – just like your accounting database **(Q8)**. Now, you can load your ODS into the data warehouse, and receive back an enterprise-wide, cleansed and reconciled version of it.

The real time data warehouse that is built from the ODSes across the firm accepts near-real time feeds of transaction data (it could be coupled to your database, rather than waiting to be loaded from it), provides near-real-time access for the transaction of processing systems to a data warehouse, and affords the ***near-immediate transformation and loading of ODS data into the warehouse*** **(Q9)**.

Ultimately, all of the transactions in the firm should be captured as database actions, or Events **(Q10)**. These events are important to your accounting department, but also to the rest of the firm. Never work in a vacuum – never be myopic. Your original ODS and the information in the Data Warehouse differ in lots of ways, ***but they do not differ in level of detail*** **(Q12).**

If you recall, our fact table had all of the transactions that are performed, as does your accounting database. I don't imagine you'd build a database for the accounting department that only had aggregate, or summary data would you? For example, you wouldn't store, at the lowest level, only those product sales from January. What point would there be in that? You want to store every sale, every sales rep who made the sale, the date of the sale, and the amount of the sale, etcetera. All this in order to ***drill down from aggregate data to a lower level*** – start in January, and then drill down to days, even seconds in January events.

Management also wants to combine your ODS with events from the rest of the firm so they can understand how a marketing event affects sales, etcetera. In this case, we would need a Marketing ODS as well as your accounting ODS. Load both of these ODSes and others across the firm and you begin to see the value of the enterprise-wide data warehouse.

This characteristic of data warehouses – that it has data from across the firm which represents an enterprise view means that ***the reconciled data are comprehensive in nature*** **(Q11)**.

The process of getting all of these ODS's into the data warehouse is arduous and is why database administrators earn lots of money. To get these data into the data warehouse you've got to ***purge data that have become obsolete (items that no longer exist), update table rows with new data, and add new rows*** **(Q14)**. If you do not want to incrementally load the data warehouse in this fashion, ***you can also purge the entire thing and load it with new data from all the ODS'; a process called refreshing*** **(Q13)** that takes a great deal of time to perform, but one that guarantees we have the latest and greatest data from around the enterprise.

Thus far, we've talked about schemas, ODS', operational and informational databases. Let's return to the data warehouse and its fact table comprised of data at an atomic level of transactions.

Although we can drill down to that level, it is time consuming and rough on the data warehouse to do so – getting to petabytes of atomic level detail takes a long time to do, although in your accounting database it would be quite easy considering the relatively small amount of data your ODS contains.

Instead, we typically ***aggregate the data*** **(Q15)** . . . instead of looking at every sale for every item, we might look at sales for a particular month, and total sales for a particular item.

Our star schema lets us do this – rather than having one table, we have those dimension tables plus the fact table. ***In fact, that's pretty much all you have in a star schema – dimension and fact tables*** **(Q16)**. As we aggregate the fact table the data warehouse becomes more and more valuable. We can look at individual items sold and

aggregate them into a '***market basket' analysis whereby we study the individual buying habits of customers*** **(Q17)**.

This is especially useful when we want to look at typical buyers' baskets of goods sold and see what consumers bought with other items. Take for instance milk and bread. When you find out that they typically appear together in a basket, you put the items on opposite ends of the store so people have to walk every aisle to get what they want which usually causes spontaneous purchasing of other products.

So, that's what you get when you summarize data and perform market basket analysis – an aggregation of data that is very useful. If, however, you go the other way – start at an aggregate level and drill down into the atomic data, you can also derive some other important facts but you have to remember that you are really taxing the database.

Having talked about building the data warehouse and also its value when we ask it questions we now turn to the problem of ***not knowing what question to ask***. There are lots of data in there and you're used to asking simple questions about your department. How do you even begin to recognize the value of the enterprise data warehouse when you don't know anything about any other department?

This is a common problem – there are usually much more data in the data warehouse than we know what to do with. All of the stovepipes are used to asking about their role, but now that all of the stovepipes are tied together, how can the data be best utilized to answer enterprise-wide questions?

Fortunately, there is a process called data mining that goes a long way to solving this issue. Data mining software lets you search for patterns and correlations in the

database without asking a question at all – this ***rule discovery process*** **(Q19)** is akin to putting a big thinking cap on top of the data warehouse and letting it go to work without your intervention.

Data mining applications don't have a penchant for any particular area of the firm – it just looks for patterns. As an example, the application might discover that sales slump every time January 4th rolls around on a Thursday.

Data mining is very powerful. You don't have to ask about January 4th, after all, who would think to ask that question? The data mining application scours the data in the database and comes up with a pattern of interest. You don't even have to tell it what patterns to look for! It is generic, data agnostic, and very intelligent.

These data mining applications can identify clusters of observations – not just one at a time – all with similar characteristics. ***By doing this process called clustering and signal processing*** **(Q18)** the data mining software becomes a powerful weapon in the corporate arsenal. For instance, the software is often used by credit card companies to identify patterns of fraudulent activities in order to stop spending when is shouldn't be occurring.

Of course, data mining is also used in other applications. For instance, marketing can employ the software in order to identify potential customers for promotional activities. ***This target marketing approach*** **(Q20)** could save a company millions of dollars by omitting certain non-responders from mailing lists, or identifying those people with a penchant for constantly buying things.

If we were to try to derive the same answers, we would have to ask about every month, every region, every item, and so on; an exhaustive task to say the least; not to mention the fact that we wouldn't have thought to ask the questions in the first place.

In summary, your small Access databases turned into important components of the enterprise. The data warehouse, and data mining applications in cahoots with ODS' and a little bit of deep thinking can carry you a long way. ***With the advances in information systems like improvements in database technology, advances in middleware products that bridge the gap between ODS' and data warehouses, and advances in hardware***, we are now able to quickly and easily put our finger on the pulse of the enterprise **(Q2)**.

So, just remember that that Access database you're building might one day become an ODS, which will roll up into a data warehouse, and be used by personnel across the enterprise to support decision making.

Appendix 8: Directions for MP3 Download

Source: Investigator.

These procedures are identical to those you would undertake to download any file type from Blackboard to an electronic device.

1. Sign in to Blackboard
2. Select and click on your [intentionally omitted] lecture section
3. At the left hand side of the screen you will see a list of menu items
    a. Click on the item at the top of the menu that says, "Audio File"
4. **Right Click** on the file "[intentionally omitted]-[your section #] Audio File for Research Study"
5. Select "Save as" or "Save Link As" (depending upon which browser you use)
6. Browse to a location on your device where you would like to save the file
7. Click "Save" or "OK" (depending upon which browser you use)

You have now downloaded the MP3 file from Blackboard. You can now listen to the MP3 on any compatible device – anytime, anywhere.

Appendix 9: Demographics Questionnaire

Source: Investigator.

Age	_____ Years Old
Gender	□ Male □ Female
Race	□ African American □ Asian □ Hispanic □ White □ Indian □ Subcontinent or Pacific Islander □ Native American □ Other: _____
Class Standing	□ Freshman □ Sophomore □ Junior □ Senior □ Other: _____

Field of Study: *4 Year Programs*	□ Accounting □ Business Economics and Public Policy □ Finance □ Information Systems □ International Business □ Management □ Marketing □ Sport, Event and Hospitality Management □ Undecided □ Other (Please see 5 Year Programs first – if applicable): _____
Field of Study: *5 Year Programs*	□ BBA/Master of Science in Information Systems Technology □ BBA/Master Tourism Administration □ Individualized Field of Study: _____ □ Dual Field of Concentration: Field 1: _____ Field 2: _____ □ Other: _____

Appendix 10: Frequency Tables

Source: Investigator.

BEHAVIORAL INTENTION

I intend to use the M-Learning MOD if offered in other courses:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	3	2.8	2.8
Disagree	16	15.0	17.8
Neutral	31	29.0	46.7
Agree	50	46.7	93.5
Strongly Agree	7	6.5	100.0
Total	107	100.0	

I plan to use the M-Learning MOD if offered in other courses:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	0.9	0.9
Disagree	14	13.1	14.0
Neutral	35	32.7	46.7
Agree	44	41.1	87.9
Strongly Agree	13	12.1	100.0
Total	107	100.0	

I predict I would use the M-Learning MOD if offered in other courses:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	2	1.9	1.9
Disagree	15	14.0	15.9
Neutral	37	34.6	50.5
Agree	42	39.3	89.7
Strongly Agree	11	10.3	100.0
Total	107	100.0	

EFFORT EXPECTANCY

I found the M-Learning MOD easy to use:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	0	0.0	0.0
Disagree	1	1.0	1.0
Neutral	26	24.8	25.7
Agree	44	41.9	67.6
Strongly Agree	34	32.4	100.0
Total	105	100.0	

Learning to operate the M-Learning MOD was easy for me:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	0	0.0	0.0
Disagree	3	2.8	2.8
Neutral	22	20.8	23.6
Agree	43	40.6	64.2
Strongly Agree	38	35.8	100.0
Total	106	100.0	

It was easy for me to become skillful at using the M-Learning MOD:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	0	0.0	0.0
Disagree	1	0.9	0.9
Neutral	36	34.0	34.9
Agree	34	32.1	67.0
Strongly Agree	35	33.0	100.0
Total	106	100.0	

My interaction with the M-Learning MOD was clear and understandable:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	0	0.0	0.0
Disagree	4	3.8	3.8
Neutral	29	27.4	31.1
Agree	45	42.5	73.6
Strongly Agree	28	26.4	100.0
Total	106	100.0	

FACILITATING CONDITIONS

(Reverse Scored): The M-Learning MOD was not compatible with other systems I use:

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	0	0.0	0.0
Agree	0	0.0	0.0
Neutral	41	40.6	40.6
Disagree	31	30.7	71.3
Strongly Disagree	29	28.7	100.0
Total	101	100.0	

I had the resources necessary to use the M-Learning MOD:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	0	0.0	0.0
Disagree	3	2.8	2.8
Neutral	24	22.6	25.5
Agree	43	40.6	66.0
Strongly Agree	36	34.0	100.0
Total	106	100.0	

I had the knowledge necessary to use the M-Learning MOD:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	0	0.0	0.0
Disagree	1	0.9	0.9
Neutral	17	16.0	17.0
Agree	47	44.3	61.3
Strongly Agree	41	38.7	100.0
Total	106	100.0	

A specific person (or group) was available for assistance with M-Learning MOD difficulties:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	2	1.9	1.9
Disagree	18	17.0	18.9
Neutral	54	50.9	69.8
Agree	19	17.9	87.7
Strongly Agree	13	12.3	100.0
Total	106	100.0	

PERFORMANCE EXPECTANCY

Using the M-Learning MOD enabled me to accomplish tasks more quickly:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	2	1.9	1.9
Disagree	24	22.6	24.5
Neutral	49	46.2	70.8
Agree	30	28.3	99.1
Strongly Agree	1	0.9	100.0
Total	106	100.0	

Using the M-Learning MOD increased my productivity:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	2	1.9	1.9
Disagree	26	24.8	26.7
Neutral	48	45.7	72.4
Agree	26	24.8	97.1
Strongly Agree	3	2.9	100.0
Total	105	100.0	

I found the M-Learning MOD useful in my coursework:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	3	2.8	2.8
Disagree	14	13.2	16.0
Neutral	44	41.5	57.5
Agree	40	37.7	95.3
Strongly Agree	5	4.7	100.0
Total	106	100.0	

If I continue to use the M-Learning MOD, I will increase my chances of getting a better grade:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	2	1.9	1.9
Disagree	12	11.2	13.1
Neutral	60	56.1	69.2
Agree	23	21.5	90.7
Strongly Agree	10	9.3	100.0
Total	107	100.0	

SOCIAL INFLUENCE

People who influence my behavior thought that I should use the M-Learning MOD:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	5	4.7	4.7
Disagree	17	16.0	20.8
Neutral	71	67.0	87.7
Agree	12	11.3	99.1
Strongly Agree	1	0.9	100.0
Total	106	100.0	

People who are important to me thought that I should use the M-Learning MOD:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	6	5.7	5.7
Disagree	15	14.2	19.8
Neutral	69	65.1	84.9
Agree	13	12.3	97.2
Strongly Agree	3	2.8	100.0
Total	106	100.0	

In general, the organization supported the use of the M-Learning MOD:

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	0	0.0	0.0
Disagree	8	7.5	7.5
Neutral	43	40.2	47.7
Agree	48	44.9	92.5
Strongly Agree	8	7.5	100.0
Total	107	100.0	

USE BEHAVIOR

Response	Frequency	Percent	Cumulative Percent
0 Overall Uses	26	24.1	24.1
1 Overall Use	41	38.0	62.0
2 Overall Uses	19	17.6	79.6
3 Overall Uses	10	9.3	88.9
4 Overall Uses	11	10.2	99.1
6 Overall Uses	1	0.9	100.0
Total	108	100.0	

Appendix 11: Data Warehousing Quiz 1

Source: Investigator.

MULTIPLE-CHOICE

Choose the one alternative that best completes the statement or answers the question

1. A data mart is a(n):

   A) A generic on-line shopping site
   B) Smaller system built upon file processing technology
   C) A data warehouse that is limited in scope
   D) Enterprisewide data warehouse

2. The characteristic that indicates that a data warehouse is organized around key high-level entities of the enterprise is:

   A) Time-variant
   B) Nonvolatile
   C) Subject-oriented
   D) Integrated

3. The real-time data warehouse is characterized by which of the following?

   A) Data are immediately transformed and loaded into the warehouse
   B) It accepts near-real time feeds of transaction data
   C) It provides near-real-time access for the transaction processing systems to an enterprise data warehouse
   D) All of the above

4. Which of the following data mining techniques identifies clusters of observations with similar characteristics?

   A) Neural nets
   B) Clustering and signal processing
   C) Rule discovery
   D) Case reasoning

5. A star schema contains both fact and _____ tables.

   A) Narrative
   B) Dimension
   C) Starter
   D) Cross functional

6. An operational data store (ODS) is a(n):

   A) Place to store all unreconciled data
   B) Representation of the operational data
   C) Integrated, subject-oriented, updateable, current-valued, detailed database designed to serve the decision support needs of operational users
   D) Small-scale data mart

7. A characteristic of reconciled data that means the data reflect an enterprisewide view is:

   A) Detailed
   B) Historical
   C) Normalized
   D) Comprehensive

8. The study of the individual buying habits of customers is called a _____ analysis.

   A) Census
   B) Market basket
   C) Demographic
   D) Purchasing power

9. Operational and informational systems are generally separated because of which of the following factors?

   A) A properly designed data warehouse adds value to data by improving their quality and consistency
   B) A separate data warehouse eliminates contention for resources that results when informational applications are confounded with operational processing
   C) A data warehouse centralizes data that are scattered throughout disparate operational systems and makes them readily available for decision support applications
   D) All of the above

10. A dependent data mart:

   A) Is dependent upon an operational system
   B) Is filled with data extracted directly from the operational system
   C) Is filled exclusively from the enterprise data warehouse with reconciled data
   D) Participates in a relationship with an entity

11. Loading data into a data warehouse involves:

   A) Appending new rows to the tables in the warehouse.
   B) Updating existing rows with new data.
   C) Purging data that have become obsolete or were incorrectly loaded.
   D) All of the above.

12. Which of the following advances in information systems contributed to the emergence of data warehousing?

   A) Advances in computer hardware, especially affordable mass storage and parallel computer architectures
   B) Advances in middleware products that enabled enterprise database connectivity across heterogeneous platforms
   C) Improvements in database technology, particularly the relational data model
   D) All of the above

13. An approach to filling a data warehouse that employs bulk rewriting of the target data periodically is called:

A) Overwrite mode
B) Refresh mode
C) Dump mode
D) Update mode

14. Which of the following factors drive the need for data warehousing?

A) Data warehouses generally have better security
B) Informational data must be kept together with operational data
C) Businesses need an integrated view of company information
D) None of the above

15. Informational and operational data differ in all of the following ways EXCEPT:

A) Scope of data
B) Data quality
C) Normalization level
D) Level of detail

16. The process of transforming data from a detailed to a summary level is called:

A) Aggregating
B) Updating
C) Extracting
D) Joining

17. Which of the following organizational trends does not encourage the need for data warehousing?

A) Downsizing
B) Multiple, nonsynchronized systems
C) Focus on supplier relationship management
D) Focus on customer relationship management

18. A database action that results from a transaction is called a(n):

A) Event
B) Journal happening
C) Transition
D) Log entry

19. Which of the following data mining applications identifies customers for promotional activity?

A) Product affinity
B) Usage analysis
C) Target marketing
D) Population profiling

20. Which of the following data-mining techniques searches for patterns and correlations in large data sets?

A) Signal processing
B) Case reasoning
C) Neural nets
D) Rule discovery

Appendix 12: Data Warehousing Quiz 2

Source: Investigator.

MULTIPLE-CHOICE

Choose the one alternative that best completes the statement or answers the question

1. The study of the individual buying habits of customers is called a _____ analysis.

   A) Demographic
   B) Market basket
   C) Census
   D) Purchasing power

2. An approach to filling a data warehouse that employs bulk rewriting of the target data periodically is called:

   A) Update mode
   B) Dump mode
   C) Overwrite mode
   D) Refresh mode

3. Which of the following data mining techniques identifies clusters of observations with similar characteristics?

   A) Rule discovery
   B) Neural nets
   C) Case reasoning
   D) Clustering and signal processing

4. Loading data into a data warehouse involves:

   A) Updating existing rows with new data
   B) Purging data that have become obsolete or were incorrectly loaded
   C) Appending new rows to the tables in the warehouse
   D) All of the above

5. A data mart is a(n):

   A) Enterprisewide data warehouse
   B) A generic on-line shopping site
   C) A data warehouse that is limited in scope
   D) Smaller system built upon file processing technology

6. The characteristic that indicates that a data warehouse is organized around key high-level entities of the enterprise is

   A) Time-variant
   B) Integrated
   C) Subject-oriented
   D) Nonvolatile

7. Which of the following factors drive the need for data warehousing?

   A) Informational data must be kept together with operational data
   B) Data warehouses generally have better security
   C) Businesses need an integrated view of company information
   D) None of the above

8. The real-time data warehouse is characterized by which of the following?

   A) It provides near-real-time access for the transaction processing systems to an enterprise data warehouse
   B) It accepts near-real time feeds of transaction data
   C) Data are immediately transformed and loaded into the warehouse
   D) All of the above

9. Which of the following organizational trends does not encourage the need for data warehousing?

   A) Focus on supplier relationship management
   B) Multiple, nonsynchronized systems
   C) Downsizing
   D) Focus on customer relationship management

10. Operational and informational systems are generally separated because of which of the following factors?

    A) A properly designed data warehouse adds value to data by improving their quality and consistency.
    B) A data warehouse centralizes data that are scattered throughout disparate operational systems and makes them readily available for decision support applications
    C) A separate data warehouse eliminates contention for resources that results when informational applications are confounded with operational processing
    D) All of the above

11. Informational and operational data differ in all of the following ways EXCEPT:

    A) Scope of data
    B) Data quality
    C) Level of detail
    D) Normalization level

12. A characteristic of reconciled data that means the data reflect an enterprisewide view is:

    A) Normalized
    B) Historical
    C) Comprehensive
    D) Detailed

13. Which of the following data mining applications identifies customers for promotional activity?

A) Usage analysis
B) Product affinity
C) Target marketing
D) Population profiling

14. Which of the following data-mining techniques searches for patterns and correlations in large data sets?

A) Case reasoning
B) Signal processing
C) Rule discovery
D) Neural nets

15. A dependent data mart:

A) Participates in a relationship with an entity
B) Is filled exclusively from the enterprise data warehouse with reconciled data
C) Is dependent upon an operational system
D) Is filled with data extracted directly from the operational system

16. A database action that results from a transaction is called a(n):

A) Journal happening
B) Log entry
C) Event
D) Transition

17. The process of transforming data from a detailed to a summary level is called:

A) Aggregating
B) Extracting
C) Updating
D) Joining

18. A star schema contains both fact and _____ tables.

A) Cross functional
B) Dimension
C) Narrative
D) Starter

19. An operational data store (ODS) is a(n):

A) Representation of the operational data
B) Small-scale data mart
C) Integrated, subject-oriented, updateable, current-valued, detailed database designed to serve the decision support needs of operational users
D) Place to store all unreconciled data

20. Which of the following advances in information systems contributed to the emergence of data warehousing?

A) Advances in computer hardware, especially affordable mass storage and parallel computer architectures
B) Improvements in database technology, particularly the relational data model
C) Advances in middleware products that enabled enterprise database connectivity across heterogeneous platforms
D) All of the above

Appendix 13. Items Used in Estimating UTAUT (Post-Factor Analysis)

Source: Adapted from Venkatesh, et al., "User Acceptance of IT," 460

Variable Measured	Modified Survey Item	Original Survey Item
1. Performance Expectancy	a. I found the M-Learning MOD useful in my coursework	a. I would find the system useful in my job
	b. Using the M-Learning MOD enabled me to accomplish tasks more quickly	b. Using the system enables me to accomplish tasks more quickly
	c. Using the M-Learning MOD increased my productivity	c. Using the system increases my productivity
	d. If I continue to use the M-Learning MOD, I will increase my chances of getting a better grade	d. If I use the system, I will increase my chances of getting a raise
2. Effort Expectancy	a. My interaction with the M-Learning MOD was clear and understandable	a. My interaction with the system would be clear and understandable
	b. It was easy for me to become skillful at using the M-Learning MOD	b. It would be easy for met to become skillful at using the system
	c. I found the M-Learning MOD easy to use	c. I would find the system easy to use
	d. Learning to operate the M-Learning MOD was easy for me	d. Learning to operate the system is easy for me

Variable Measured	Modified Survey Item	Original Survey Item
3. Social Influence	a. People who influence my behavior thought that I should use the M-Learning MOD	a. People who influence my behavior think that I should use the system
	b. People who are important to me thought that I should use the system	b. People who are important to me think that I should use the system
	~~c. The senior management of this business has been helpful in the use of the system~~	c. The senior management of this business has been helpful in the use of this system
	d. In general, the organization supported the use of the M-Learning MOD	d. In general, the organization has supported the use of the system
4. Facilitating Conditions	a. I had the resources necessary to use the M-Learning MOD	a. I have the resources necessary to use the system
	b. I had the knowledge necessary to use the M-Learning MOD	b. I have the knowledge necessary to use the system
	c. The M-Learning MOD was not compatible with other systems I use	c. The system is not compatible with other systems I use
	d. A specific person (or group) was available for assistance with M-Learning MOD difficulties	d. A specific person (or group) is available for assistance with system difficulties
5. Behavioral Intent to Use the System	a. I intend to use the M-Learning MOD if offered in other courses	a. I intend to use the system in the next <n> months
	b. I predict I would use the M-Learning MOD if offered in other courses	b. I predict I would use the system in the next <n> months
	c. I plan to use the M-Learning MOD if offered in other courses	c. I plan to use the system in the next <n> months

Appendix 14. Study UTAUT Survey

Source: Adapted from Venkatesh, et al., "User Acceptance of Information Technology," 460.

Item Number	Question				
1	**I felt that using the M-Learning MOD was voluntary**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5

Item Number	Question				
2	**How many times did you use the M-Learning MOD?**				
	Never 1	1-5 Times 2	6-10 Times 3	11-15 Times 4	>15 Times 5

Item Number	Question				
1	**Using the M-Learning MOD enabled me to accomplish tasks more quickly**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
2	**People who influence my behavior thought that I should use the M-Learning MOD**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
3	**Using the M-Learning MOD increased my productivity**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
4	**The M-Learning MOD was not compatible with other systems I use**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
5	**I found the M-Learning MOD useful in my coursework**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5

Item Number	Question				
6	**People who are important to me thought that I should use the M-Learning MOD**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
7	**I intend to use the M-Learning MOD if offered in other courses**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
8	**In general, the organization supported the use of the M-Learning MOD**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
9	**I had the resources necessary to use the M-Learning MOD**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
10	**I found the M-Learning MOD easy to use**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
11	**Learning to operate the M-Learning MOD was easy for me**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
12	**It was easy for me to become skillful at using the M-Learning MOD**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
13	**I had the knowledge necessary to use the M-Learning MOD**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
14	**I plan to use the M-Learning MOD if offered in other courses**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
15	**My interaction with the M-Learning MOD was clear and understandable**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5

Item Number	Question				
16	**A specific person (or group) was available for assistance with M-Learning MOD difficulties**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
17	**If I continue to use the M-Learning MOD, I will increase my chances of getting a better grade**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
18	**I predict I would use the M-Learning MOD if offered in other courses**				
	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5

Appendix 15. Research Design Overview

Source: Investigator.

Time	Control Group	Treatment Group
T1	Study Described IRB Study Procedures Distributed Pseudonyms Distributed Consent to Participate Returned FTF Lecture Delivered FTF Lecture converted to MP3 MP3 File Posted to Blackboard	Study Described IRB Study Procedures Distributed Pseudonyms Distributed Consent to Participate Returned
T1-T2		Unlimited Access to M-Learning MOD
T2	Questionnaire Completed Quiz 1 Completed	Questionnaire Completed Quiz 1 Completed
T2-T3	Unlimited Access to M-Learning MOD	Unlimited Access to M-Learning MOD
T3	Quiz 2 Completed UTAUT Survey Completed	Quiz 2 Completed UTAUT Survey Completed

Appendix 16: Reliability Analyses

Source: Investigator.

BEHAVIORAL INTENTION

Reliability Statistics

Cronbach's α	Cronbach's α Based on Standardized Items	N of Items
.930	.930	3

Item Statistics

	Mean	Std. Deviation	N
Q07 BI	3.39	.919	107
Q14 BI	3.50	.905	107
Q18 BI	3.42	.922	107

Inter-Item Correlation Matrix

	Q07 BI	Q14 BI	Q18 BI
Q07 BI	1.000		
Q14 BI	.860	1.000	
Q18 BI	.783	.806	1.000

Summary Item Statistics

	Mean	Minimum	Maximum	Variance	N of Items
Item Means	3.439	3.393	3.505	.003	3

EFFORT EXPECTANCY

Reliability Statistics

Cronbach's α	Cronbach's α Based on Standardized Items	N of Items
.906	.908	4

Item Statistics

	Mean	Std. Deviation	N
Q10 EE	4.06	.782	105
Q11 EE	4.10	.820	105
Q12 EE	3.98	.843	105
Q15 EE	3.92	.829	105

Inter-Item Correlation Matrix

	Q10 EE	Q11 EE	Q12 EE	Q15 EE
Q10 EE	1.000			
Q11 EE	.890	1.000		
Q12 EE	.760	.754	1.000	
Q15 EE	.674	.663	.521	1.000

Summary Item Statistics

	Mean	Minimum	Maximum	Variance	N of Items
Item Means	4.017	3.924	4.105	.006	4

FACILITATING CONDITIONS : (R) = REVERSE SCORED

Reliability Statistics

Cronbach's α	Cronbach's α Based on Standardized Items	N of Items
.609	.630	4

Item Statistics

	Mean	Std. Deviation	N
Q04-FC(r)	3.88	.828	101
Q09 FC	4.05	.841	101
Q13 FC	4.20	.749	101
Q16 FC	3.22	.912	101

Inter-Item Correlation Matrix

	Q04-FC(r)	Q09 FC	Q13 FC	Q16 FC
Q04-FC(r)	1.000			
Q09 FC	.497	1.000		
Q13 FC	.571	.572	1.000	
Q16 FC	.061	.051	.039	1.000

Summary Item Statistics

	Mean	Minimum	Maximum	Variance	N of Items
Item Means	3.837	3.218	4.198	.187	4

PERFORMANCE EXPECTANCY

Reliability Statistics

Cronbach's α	Cronbach's α Based on Standardized Items	N of Items
.821	.821	4

Item Statistics

	Mean	Std. Deviation	N
Q01-PE	3.04	.796	105
Q03-PE	3.02	.832	105
Q05 PE	3.29	.863	105
Q17 PE	3.25	.852	105

Inter-Item Correlation Matrix

	Q01-PE	Q03-PE	Q05 PE	Q17 PE
Q01-PE	1.000			
Q03-PE	.624	1.000		
Q05 PE	.558	.582	1.000	
Q17 PE	.340	.509	.596	1.000

Summary Item Statistics

	Mean	Minimum	Maximum	Variance	N of Items
Item Means	3.148	3.019	3.286	.019	4

SOCIAL INFLUENCE

Reliability Statistics

Cronbach's α	Cronbach's α Based on Standardized Items	N of Items
.729	.731	3

Item Statistics

	Mean	Std. Deviation	N
Q02-SI	2.88	.700	106
Q06 SI	2.92	.777	106
Q08 SI	3.52	.746	106

Inter-Item Correlation Matrix

	Q02-SI	Q06 SI	Q08 SI
Q02-SI	1.000		
Q06 SI	.666	1.000	
Q08 SI	.397	.364	1.000

Summary Item Statistics

	Mean	Minimum	Maximum	Range	N of Items
Item Means	3.107	2.877	3.519	.642	3

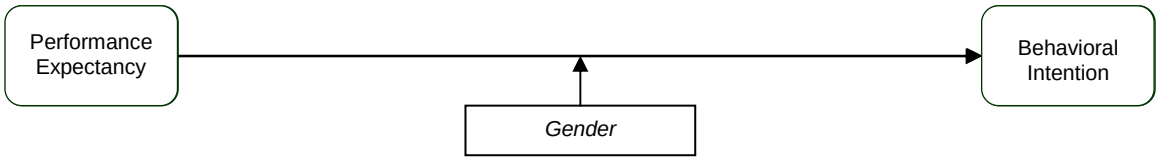
Appendix 17: Results of Hypotheses Testing

Source: Investigator.

Performance Expectancy

H1a: Fail to Reject H_0

H_0 The effect of Performance Expectancy on Behavioral Intention ***will not*** be moderated by Gender such that the effect will be stronger for men.



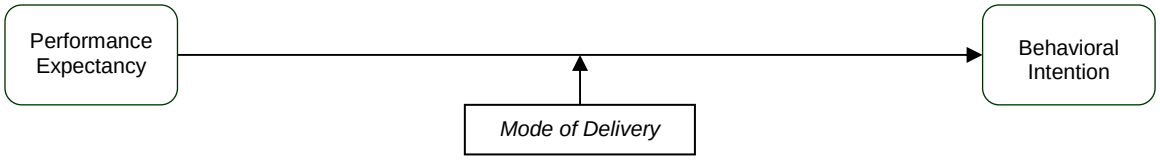
H_a The effect of Performance Expectancy on Behavioral Intention ***will*** be moderated by Gender such that the effect will be stronger for men.

Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance[1]
PE	.501	.506	0.742	0.000***
GDR	.497	.001	0.024	0.733
PE*GDR	.493	.001	-0.047	0.619

1. *p<.05; **p<.01; ***p<.001

H1b: Fail to Reject H_0

H_0: The effect of Performance Expectancy on Behavioral Intention ***will not*** be moderated by Mode of Delivery.



H_a: The effect of Performance Expectancy on Behavioral Intention ***will*** be moderated by Mode of Delivery.

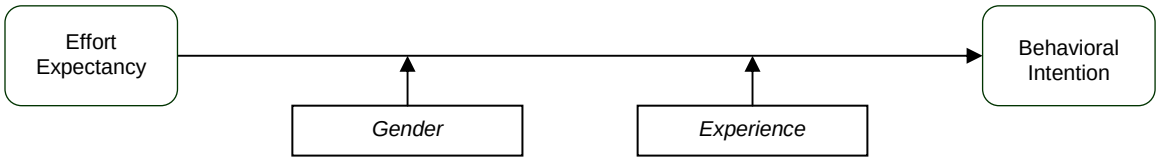
Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance[1]
PE	.497	.502	0.675	0.000***
MOD	.493	.001	-0.036	0.609
PE*MOD	.489	.001	0.041	0.718

1. *p<.05; **p<.01; ***p<.001

Effort Expectancy

$H2_a$: Fail to reject H_0

$H2_0$: The effect of Effort Expectancy on Behavioral Intention ***will not*** be moderated by Gender and Experience such that the effect will be stronger for women and particularly at early stages of exposure to the M-Learning MOD.



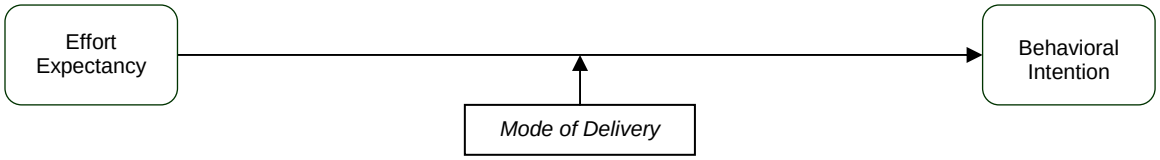
$H2_a$: The effect of Effort Expectancy on Behavioral Intention ***will*** be moderated by Gender and Experience such that the effect will be stronger for women and particularly at early stages of exposure to the M-Learning MOD.

Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance[1]
EE	.064	.073	-.057	.861
GDR	.055	.000	.006	.955
EXP	.051	.005	.062	.652
EE*GDR	.041	.000	-.029	.828
EE*EXP	.033	.001	.369	.277
GDR*EXP	.037	.014	-.135	.337
EE*GDR*EXP	.063	.034	-.250	.057

1. *p<.05; **p<.01; ***p<.001

H2b: Fail to reject H_0

$H_{0:}$ The effect of Effort Expectancy on Behavioral Intention ***will not*** be moderated by Mode of Delivery.



$H_{a:}$ The effect of Effort Expectancy on Behavioral Intention ***will*** be moderated by Mode of Delivery.

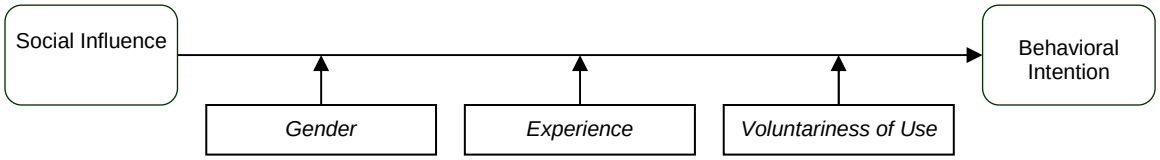
Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance[1]
EE	.069	.078	.311	0.012*
MOD	.071	.010	-.103	0.289
EE*MOD	.062	.000	-.024	0.841

1. *p<.05; **p<.01; ***p<.001

Social Influence

H3a: Fail to reject H_0

$H_{0:}$ The effect of Social Influence on Behavioral Intention ***will not*** be moderated by Gender, Experience, and Voluntariness such that the effect will be stronger for women particularly in mandatory settings in the early stages of Experience with the M-Learning MOD.



$H_{a:}$ The effect of Social Influence on Behavioral Intention ***will*** be moderated by Gender, Experience, and Voluntariness such that the effect will be stronger for women particularly in mandatory settings in the early stages of Experience with the M-Learning MOD.

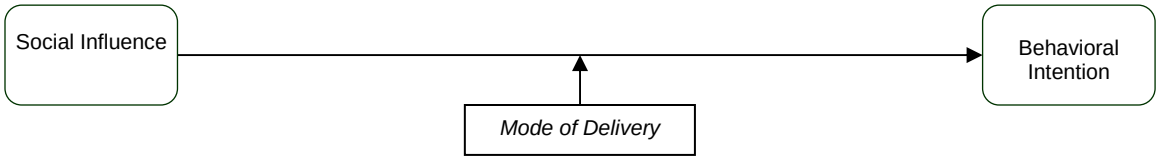
Hypothesis	Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance$_1$
H3a$_1$	SI	.208	.215	.575	.000***
	GDR	.205	.005	.055	.543
	EXP	.199	.002	.052	.677
	VOL	.219	.027	-.162	.228
	SI*GDR	.217	.006	-.125	.398
	SI*EXP	.209	.000	-.018	.851
	SI*VOL	.206	.005	.089	.346
	GDR*EXP	.209	.010	-.147	.248
	GDR*VOL	.201	.000	.020	.882
H3a$_2$	SI	.208	.215	.446	.000***
	GDR	.205	.005	.075	.411
	EXP	.199	.002	-.013	.883
	VOL	.219	.027	-.180	.050
	EXP*VOL	.218	.007	.061	.632
	SI*GDR*EXP	.216	.006	.107	.309
	SI*GDR*VOL	.213	.004	-.070	.466
	GDR*EXP*VOL	.205	.000	.005	.970
H3a$_3$	SI	.208	.215	.496	.000***
	GDR	.205	.005	.080	.372
	EXP	.199	.002	-.026	.770

Hypothesis	Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance[1]
	VOL	.219	.027	-.165	.063
	SI*GDR*EXP*VOL	.212	.001	-.035	.708

1. *p<.05; **p<.01; ***p<.001

H3b: Fail to reject H_0

$H_{0:}$ The effect of Social Influence on Behavioral Intention ***will not*** be moderated by Mode of Delivery.



$H_{a:}$ The effect of Social Influence on Behavioral Intention ***will*** be moderated by Mode of Delivery.

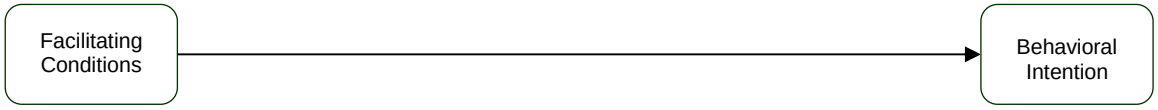
N	Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance[1]
106	SI	.192	.200	0.473	0.002**
	MOD	.189	.005	-0.71	0.422
	SI*MOD	.181	.000	-0.029	0.848

1. *p<.05; **p<.01; ***p<.001

Facilitating Conditions

H4a: Fail to reject H_0

$H_{0:}$ The effect of Facilitating Conditions ***will*** have a significant influence on Behavioral Intention.



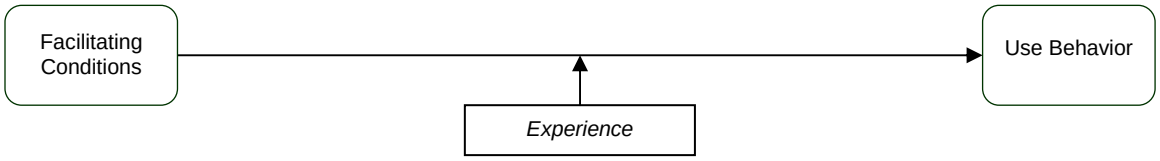
$H_{a:}$ The effect of Facilitating Conditions ***will not*** have a significant influence on Behavioral Intention.

N	Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance[1]
101	FC	.098	.107	0.327	0.001**

1. *p<.05; **p<.01; ***p<.001

H4b: Fail to reject H_0

$H_{0:}$ The effect of Facilitating Conditions on M-Learning MOD Use Behavior ***will not*** be moderated by Experience with the M-Learning MOD such that the effect will be stronger for students with increasing Experience.



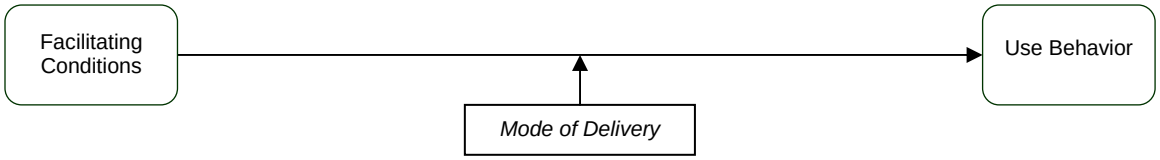
$H_{a:}$ The effect of Facilitating Conditions on M-Learning Use Behavior ***will*** be moderated by Experience with the M-Learning MOD such that the effect will be stronger for students with increasing Experience.

N	Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance[1]
101	FC	.007	.017	0.007	0.944
	EXP	.166	.166	.435	0.000***
	FC*EXP	.173	.014	-.121	0.193

1. *p<.05; **p<.01; ***p<.001

H4c: Fail to reject H_0

$H_{0:}$ The effect of Facilitating Conditions on M-Learning MOD Use Behavior ***will not*** be moderated by Mode of Delivery.



$H_{a:}$ The effect of Facilitating Conditions on M-Learning MOD Use Behavior ***will*** be moderated by Mode of Delivery.

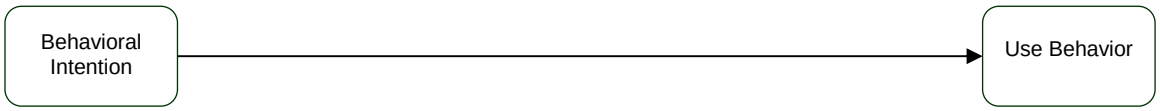
N	Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance[1]
101	FC	.007	.017	0.131	0.289
	MOD	.155	.154	0.418	0.000***
	FC*MOD	.163	.017	-0.173	0.157

1. *p<.05; **p<.01; ***p<.001

Behavioral Intention

H5: Fail to reject H_0

$H_{0:}$ The effect of Behavioral Intention on M-Learning MOD Use Behavior ***will not*** be moderated by Gender.



$H_{a:}$ The effect of Behavioral Intention on M-Learning MOD Use Behavior ***will*** be moderated by Gender

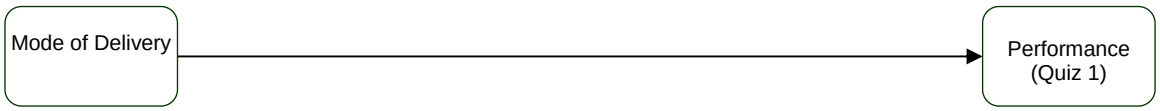
N	Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance
107	BI	-.008	.003	-0.087	0.556

1. *p<.05; **p<.01; ***p<.001

Performance, Mode of Delivery

H6a: Reject H_0

$H_{a:}$ Mode of Delivery ***will*** have an influence on Quiz 1 Performance.



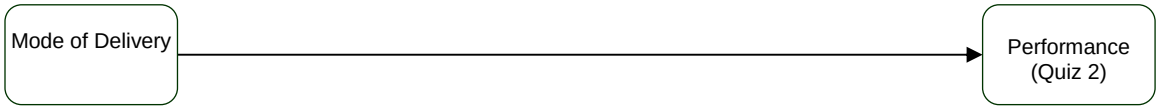
$H_{0:}$ Mode of Delivery ***will not*** have an influence on Quiz 1 Performance.

N	Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance
108	MOD	.106	.114	-0.338	0.000***

1. *p<.05; **p<.01; ***p<.001

H6b: Reject H_0

$H_{a:}$ Mode of delivery ***will*** have an influence on Quiz 2 Performance.



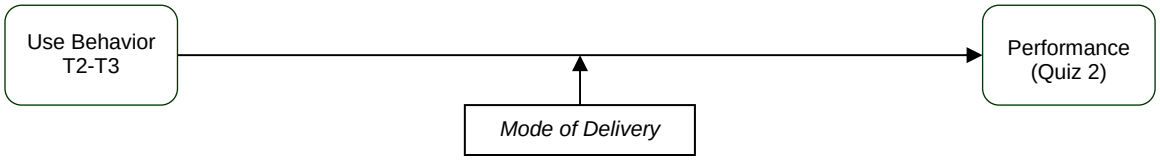
$H_{0:}$ Mode of delivery ***will not*** have an influence on Quiz 2 Performance.

N	Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance[1]
108	MOD	.052	0.061	-0.247	0.010*

1. *p<.05; **p<.01; ***p<.001

H6c: Fail to reject H_0

$H_{0:}$ The effect of Use Behavior between Time 2 and Time 3 on Quiz 2 Performance ***will not*** be moderated by Mode of Delivery.



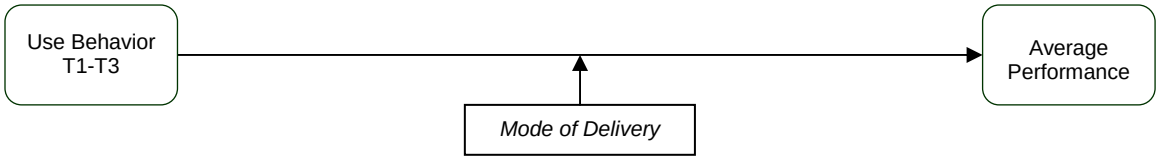
$H_{a:}$ The effect of Use Behavior between Time 2 and Time 3 on Quiz 2 Performance ***will*** be moderated by Mode of Delivery.

N	Variables/Interactions	Adjusted R^2	ΔR^2	Standardized β	Significance[1]
108	UB T2-T3	.003	0.013	-0.030	0.825
	MOD	.055	0.060	-0.245	0.011*
	UBT2-T3*MOD	.052	0.006	-0.109	0.418

1. *p<.05; **p<.01; ***p<.001

H6d: Fail to reject H_0

$H_{0:}$ The effect of Use Behavior between T1 and T3 on Average Performance over Quiz 1 and Quiz 2 ***will not*** be moderated by Mode of Delivery.



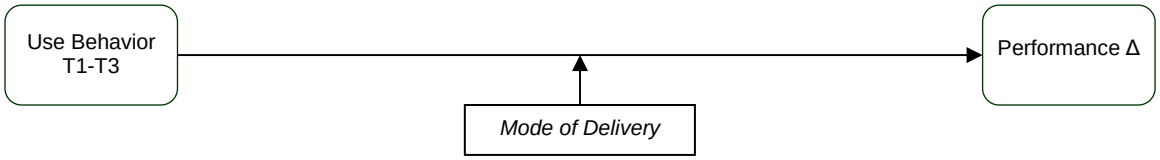
$H_{a:}$ The effect of Use Behavior between T1 and T3 on Average Performance over Quiz 1 and Quiz 2 ***will*** be moderated by Mode of Delivery.

N	Variables/Interactions	R^2	ΔR^2	Standardized β	Significance[1]
108	UB	-.003	0.006	.049	.752
	MOD	.081	0.093	-.330	0.002**
	UB*MOD	.072	.000	.001	0.996

1. *p<.05; **p<.01; ***p<.001

H6e: Fail to reject H_0

H_0 The effect of Use Behavior on the difference between Performance on Quiz 1 and Quiz 2 ***will not*** be moderated by Mode of Delivery.

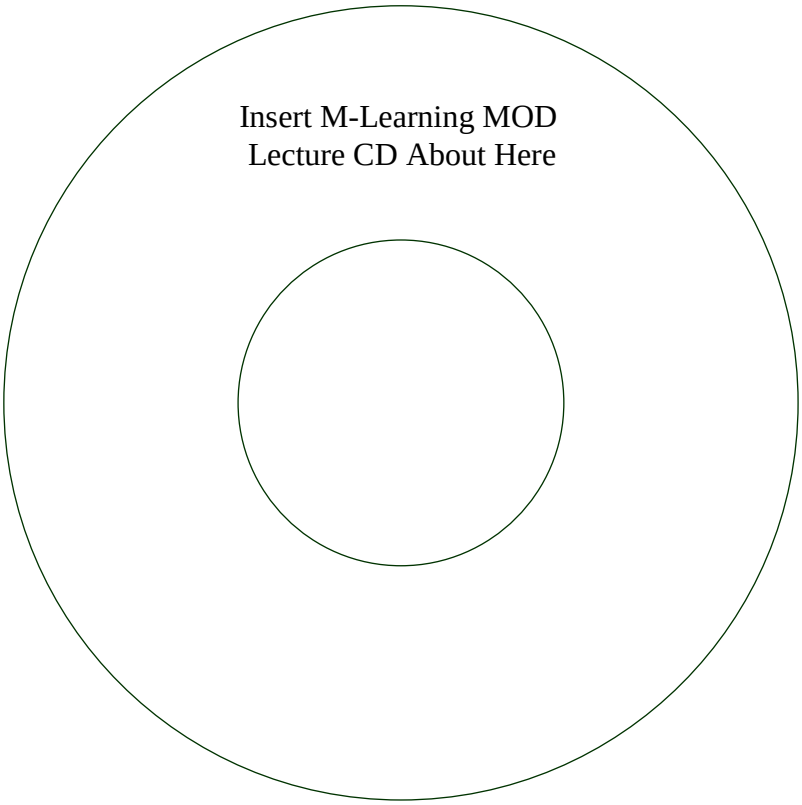


$H_{a:}$ The effect of Use Behavior on the difference between Performance on Quiz 1 and Quiz 2 ***will*** be moderated by Mode of Delivery.

N	Variables/Interactions	R^2	ΔR^2	Standardized β	Significance[1]
107	UB	-.005	0.004	-0.170	0.293
	MOD	-.004	0.010	0.114	0.287
	UB*MOD	-.012	0.003	0.079	0.607

1. *p<.05; **p<.01; ***p<.001

Attachments

Attachment 1: M-Learning MOD Recording

Source: Investigator.