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USING LEARNING TAXONOMY TO ENHANCE UNDERSTANDING OF INNOVATION ADOPTION

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Abstract

Innovators, early adopters, majority and laggards are components of what is known as Innovation Diffusion Theory (IDT) and represent groups as they adopt a new innovation. Education professionals have likely heard of Bloom's Revised Taxonomy (BRT), which represents the loose progression from basic to advanced cognition in a learning process. These two theories are rarely discussed together and that is unfortunate because of the time and cost significance of too frequent failed implementations of new innovations. IDT identifies training and knowledge transfer as important components in knowledge, persuasion and decision stages of the innovation adoption process. However, previous research did not answer an important question: How do different adopter groups demonstrate various levels of cognition in the process of the adoption of a new innovation?

In an attempt to investigate this issue, this research looked at the adoption of Reference Management software by academics to explore the possible relationship between IDT and BRT. A Canada-wide online survey was conducted with 462 participants consisting of graduate students and faculty. Data were analyzed with descriptive statistics, Principal Components Analysis and correlation procedures. A thematic analysis of qualitative semi-structured interviews with 12 respondents gave the findings additional depth.

Three significant findings emerged. One, demonstration by the respondents of higher order functions in the software was correlated to the demonstration to lower order functions as theorized by BRT's progression of cognitive processes. Two, the degree of innovativeness of the participants' correlates to mastery of both

basic and advanced functions. Three, laggards, in terms of adoption, demonstrate less mastery of the basic features and functions of an innovation implying that different IDT groups respond differently within BRT cognition levels.

The implication of these findings is that training effectiveness in the supporting of the adoption of a new innovation is not solely dependent on either the training design or principles of BRT, nor is it solely influenced by the factors involved in the diffusion of an innovation. Together, these findings inform us to how we can use BRT and IDT in the knowledge transfer component of supporting the adoption of an innovation than commonly used current practices.

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Chapter One - Introduction

The process by which an innovation or technology is incorporated by a group or an individual is described as the *adoption cycle* in Rogers' (1962) seminal book, *Diffusion of Innovations*. Innovations are exhibited in the workplace and in our personal lives (Moore, 2001; Rogers, 2003). We care about understanding innovation adoption better because the successful implementation, and end-user adoption, of these innovations can have a significant impact for organizations in all sectors (Jasperson, Carter & Zmud, 2005; Tyre & Orlikowski, 1993; Lee & Xia, 2005; Cardozo, McLaughlin, Harmon, Reynolds & Miller, 1993). However, the ability of people to learn and the conditions in which they work together, to adopt and effectively use a new technology is not consistent, and this becomes an issue for an organization and its employees. Significant resources, e.g., financial and time, are invested in adopting new systems and processes. Therefore, in constrained environments, effective use of these resources is paramount for an efficient adoption. According to Ensminger and Surry (2008), between fifty and seventy-five percent of innovation adoptions fail in some way to meet their intended objectives.

As individuals, as colleagues, and from research, we know that different people adopt innovations at different rates. As a common nomenclature to discuss the different groups of adopters, they are often classified into groups such as innovators, early adopters, early majority, late majority and laggards (Moore, 2001; Rogers, 1962) which will be referred to as *adopter cohorts* in this study. This construct of *adopter classification* allows us to describe adopters in a general way relative to their propensity to adopt an innovation. As described by Rogers (1962) and Moore (2001), innovators are those that adopt an innovation, often for the sake of experimentation or interest in innovation itself. Early adopters are those that are the first to value the identified purpose of the innovation, with sufficient energy to adopt that innovation. The early majority are those that adopt the innovation once the innovation is considered to be of proven value and the late majority are those that adopt because the innovation is now considered mainstream. The laggards represent those that adopt only when there is little or no opportunity to not adopt. Despite the many components of the adoption process, which will be described further in the literature review the role of learning is just one. For the purposes of this dissertation learning is being generally defined as how we acquire or modify our knowledge and skills, However, a more precise definition that is appropriate comes from that proposed by Lachman (1997, p. 477): "learning is the process by which a relatively stable modification in stimulus-response relations is developed as a consequence of functional environmental interaction via the senses". Limited attention has been given to the relationship between the different adopter groups and the role of learning in the process.

Learning as a Component of the Adoption of an Innovation

The process of the adoption of an innovation is not a single independent event and there are complexities and nuances (Devaraj & Kohli, 2003; Gersick, 1991; Rogers, 2003). When examining a technological innovation, multiple technologies in the same cluster can be adopted faster, demonstrating that knowledge acquisition has a transferable component (Rogers, 2003). Cluster, in this respect, could be a technology family such as general office-based software (i.e., word processing and spreadsheets). Repetition, which results in the reduction of effort, is a principle of knowledge acquisition, described as a learning curve (Ebbinghaus, 1885). In general, learning curves represent the ability of individuals to increase their knowledge, understanding, and application of a new innovation (Lieberman, 1987; Rogers, 2003). These learning curves are related to complex systems and shared constraints (Gersick, 1991).

Similar to progression on a learning curve, learning taxonomy suggest levels of progressing cognition (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). Elements which influence the movement through levels of cognition have potential implications on the systemic diffusion of an innovation and on how to accelerate the comprehension for each adopter cohort. Thus, a learning taxonomy provides a framework to understand and differentiate learning events in an instructional process (Denton, Armstrong & Savage, 1980; Gagne, Briggs & Wager, 1992). A common way to construct learning taxonomies is through levels of cognition (Bloom et al., 1956; Anderson & Krathwohl, 2001). These learning taxonomies then provide a way to classify activities in a loosely hierarchal form that represents increasing complexity and higher levels of learning potential and value (Bloom et al, 1956; Anderson & Krathwohl, 2001). To date, little research has been done associating learning taxonomies and the adoption of innovations. By connecting these two frameworks it represents an opportunity to better understand the adoption of an innovation.

Purpose and Significance of the Study

The primary objective for this dissertation is to investigate how the cognitive elements embedded in learning taxonomies interface with the different traits of adoption cohorts in IDT. Additionally, this research examines the degree of usage of a new innovation from a learning theory perspective. This is a particularly important contextual feature in this research as understanding the similarities and the differences between the natures of the adopter cohorts will assist in effectively tailoring the learning experience to enhance adoption of innovations. This dissertation provides a theoretical contribution that links two established – but rarely connected – theories, one related to learning, and the other related to the adoption of an innovation. In combination the two theories provide an enhanced understanding of the role of learning in the adoption process.

The dissertation reviews in Chapter 2 the applicable literature that focuses on the intersection of these two fields. This chapter includes the exploration of innovation diffusion theory, examination of various learning taxonomies, and investigation of the connections between the two domains. The next chapter (Chapter 3) highlights the research objective and articulates the model development. It provides the research questions, context, and scope of the study. Chapter 4 examines the methodologies used in past research, both seminal and recent, and outlines the methodology used in this research. The next chapter (Chapter 5) states the findings from the study. Chapter 6 reviews the findings in the context of the literature review, the research problem and the overall linkages being investigated. Chapter 6 also discusses the limitations and future research opportunities. Chapter 7 is the conclusion and also speaks to recommendations for practice.

Chapter Two - Literature Review

This literature review covers the core topics related to the role of learning in the innovation adoption process. It begins with an exploration of adoption of innovation in the first section, and focuses on Rogers' Innovation Diffusion Theory (IDT). This first section overviews the diffusion of an innovation, how it works, and what it affects. The second section of the literature review explores learning taxonomies, in particular Bloom's Revised Taxonomy (BRT). This is critical to understanding the progression of cognitive processes, how people move through a loose progression of cognition, and what indicators define the different levels or types of cognition. The third section of the literature review explores the connection between IDT and BRT. In that section we intersect the two theories and identify the potential advantages that each contributes towards understanding the role of learning in innovation adoption. The review concludes with a summary of the contribution of the literature to this topic and lays the foundation for the rest of the dissertation.

Innovation Diffusion Theory

This first section of the literature review examines existing literature on what adoption of an innovation is and how the IDT theoretical framework describes the stages and characteristics of the adoption of innovations. It highlights the learning and experience factors in the adoption process. It then identifies perspectives from the literature on the role of learning in the adoption process for both individuals and groups, based on these characteristics. The section concludes with critiques of IDT theory and what gaps exist that lay the foundation of the research question in this study.

New innovation adoption

The arrival of a new product or innovation into a population has been described using a biological analogy. This process is defined as the Product Life Cycle or PLC (Cox, 1967) and the development of new products have been identified as having phases or stages in its adoption into the market where products follow a patterned sequence that starts from birth and moves through various stages in the market culminating with decline or death (Cox, 1967; Day, 1981). Often described as a *bell-curve* style normal distribution from introduction to decline as seen in Figure 2.1 below (Midgley, 1981), this analogy, though challenged and adapted (Cao & Folan, 2012; Taylor & Taylor, 2012) survives in part due to its simplicity and ease of understanding.

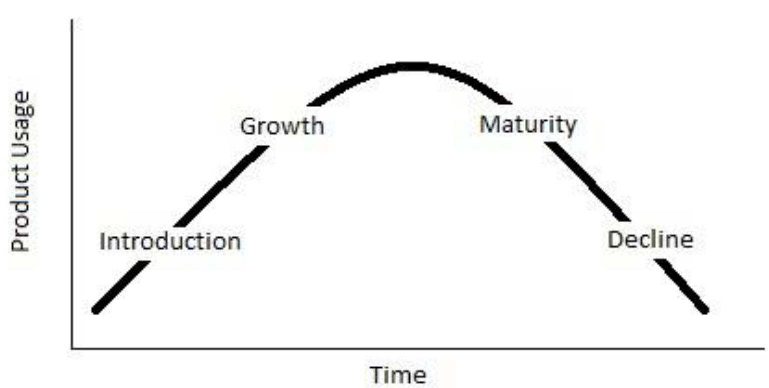

Figure 2.1 Product Life Cycle (adapted from Cox, 1967)

A particularly controversial aspect of the bell curve model is that in real life the curve representing an actual product life cycle is rarely smooth. The literature on this topic identifies various adaptations of the generalized curve that often result in different shapes of curves for different products. Numerous mathematical formulas have been developed to describe the different curves for a variety of conditions (Bass, 1969; Cox, 1967; Midgley, 1981). Brown (1992), in particular, discusses an approach of the segmentation of the stages of the PLC compared to the smooth single curve model. A common critique of the PLC model highlights the lack of systematic research into the various shapes of the curves of a PLC and criticizes the proposition of a generalized strategic plan for each stage of the PLC (Day, 1981).

One particular model reviews the stages of adoption of innovative products and services as the 'diffusion of innovations' which distinguished adopting segments of the population by the stage in the overall cycle where the innovation is adopted (Rogers, 1962; 1981; 2003). This model originated in the 1940's from rural sociology regarding diffusion of hybrid seed corn in Iowa (Ryan & Gross, 1943). It is described in greater detail in the next section.

Overview of IDT adoption cycle

A search of the literature in the ABInform database (http://0-search.proquest.com.aupac.lib.athabascau.ca/abiglobal/index) in August 2014 yielded over 25,000 peer reviewed, scholarly publications concerning a technology adoption cycle (or diffusion of innovations, or IDT) that describe or analyze how new innovations, whether products or services, are adopted by populations. IDT is a theory that explains the process by which a new and successful innovation is identified, accepted and then cascaded through groups of people. Seminal works by Beal, Rogers and Bohlen (1957) in rural sociology, Bass (1969) in consumer durables, and Rogers (1962) generalized model each made significant contributions to the understanding of the phenomena of innovation adoption. These works explored the factors, conditions and principles that contribute to, or resist, the process of adoption.

There are three important aspects of Rogers' (1962) generalized model of IDT that are particularly relevant to this topic. First, there are five stages in the adoption process including *knowledge, persuasion, decision, implementation and confirmation* (Table 2.1) (Rogers, 1962, 2003). The knowledge stage is when one becomes aware of the existence of the innovation, persuasion is the formation of general perception or opinion of the innovation, decision is where the choice to adopt or reject the innovation is made, implementation is the overt behaviour change to use the innovation, and confirmation occurs when the user seeks reinforcement of the decision that will either support continuation or discontinuation of use (Rogers, 2003). The ARCS model of motivation (Keller, 2010) is consistent with this progression as attention and relevance play heavily towards the knowledge and persuasion stages and confidence and satisfaction can influence the implementation and confirmation stages.

Table 2.1 *The stages of the innovation adoption process (Rogers, 2003, p. 169)*

Stage	Definition	Illustrative Example
Knowledge	Exposed to existence and understands functions	Awareness that a consumer electronic exists
Persuasion	Forms an attitude towards the innovation	Messages about the consumer electronic
Decision	Engages in activities that lead to choice to adopt or not	Trial by self or by peer to test the use of the consumer electronic
Implementation	Puts the innovation to use	Use of the consumer electronic post decision to implement
Confirmation	Seeks reinforcement of the already made decision	Review to determine if the adoption of the consumer electronic was a good decision

Second, the rate at which an individual moves through those five stages in the adoption of an innovation can be influenced by a number of factors including the innovation itself (consisting of the sub-factors of relative advantage, compatibility, complexity, trialability and observability as indicated in Table 2.2 with an illustrative example using aerodynamic handlebars on a racing bicycle), communication channels, time, and the social system (Rogers, 1962, 2003).

Table 2.2 *The five sub-factor attributes of the innovation adoption process (Rogers, 2003)*

Sub-factor attribute	Description	Illustrative Example
Relative Advantage	A measure of by how much the innovation is better than its predecessor idea / process	Aerodynamic handlebars on a racing bicycle versus a traditional straight bar to reduce wind resistance
Compatibility	For potential adopters, the perceived degree with which the innovation is consistent with their values, experiences and needs	In a racing bike, wind resistance reduction is important and racers recognize that benefit as a notable factor
Complexity	The degree with which the innovation is difficult to understand or understand	If the aerodynamic handlebars are more difficult to install, steer with, or attach shifting levers to
Trialability	The ability to test the innovation on a trial basis	If you can test the handling and performance of the new handlebars on your bike or another bike without committing to switch to them permanently
Observability	The degree to which you can see the results of the innovation in a clear or visible way	Are you able to see wind tunnel data for the wind resistance reduction, or do you see rider performance in other riders in races who use the new handlebars

Later research has found varying degrees of support for these innovation characteristics (Agarwal & Prasad, 1997; Karahanna, Straub & Chervany, 1999; Moore & Benbasat, 1991; Plouffe, Hulland & Vandenbosch, 2001). The interaction of all of these factors results in different overall speeds of adoption (Day, 1981). For example, individuals may exhibit different durations of time in the knowledge stage based on the social network they are in. They may have different access via formal and informal communication related to the innovation. Complexity of the innovation can influence both the implementation stage and the persuasion stage. Furthermore, “with complex or more difficult systems, ease of use may have a greater impact on intentions” (Davis, Bagozzi & Warshaw, 1989, p. 999) to adopt an innovation.

Third, and most pertinent to this discussion, is that success depends not only on the characteristics of the innovation, but also on the characteristics of the agent(s) to whom the innovation is directed (Hartwick & Barki, 1994; Karahanna et al., 1999: Martinez, Polo & Flavian, 1998). Individuals and organizations have varying propensity to adopt an innovation (Christensen, 1997) and are often described by different classifications into categories (Brown, 1992; Kundu & Roy, 2010; Moore, 2001; Rogers, 1962). The most common classification of categories with respect to time of adoption was developed by Rogers and it consists of *innovators, early adopters, early majority, late majority and laggards* (Rogers, 1962) – see Figure 2.2.

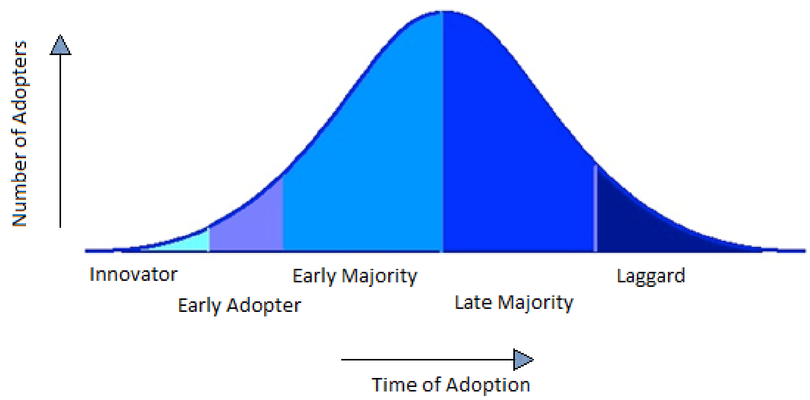

Figure 2.2 IDT Categories (adapted from Rogers, 1962)

Significant effort and studies in the literature have investigated this adopter classification system and tested its validity in many different contexts including numerous mathematical and theoretical models that have been applied to examine the classification schema (Bass, 1969; Mahajan, Muller & Srivastava, 1990; Martinez & Polo, 1996; Martinez et al., 1998; Petersen, 1973; Rogers, 1962). Many of these studies use time to adoption as the primary independent variable in the classification that allows comparisons, while others do not (Bass, 1969; Mahajan et al., 1990). While chronological order is often a corollary of the speed of adoption, it is not a required characteristic at the individual level (Rogers, 1983; Rogers & Shoemaker, 1971; Delre, Jager, Bijmolt & Janssen, 2010). Furthermore, since the adoption of an innovation is influenced by a number of variables such as social systems, communication, compatibility, and complexity (Rogers, 1962), in addition to time, then time of adoption does not serve well as the sole determinate of innovativeness or adopter classification.

As a result, an important distinction in the adoption categories is that innovators are relatively quicker in the process of adoption, not necessarily that innovators adopted the innovation before others (Rogers, 1983; Rogers & Shoemaker, 1971). One such example is when a geographical region has a greater overall adoption than another. In this case, an innovator in one region may adopt later than an early majority member in another region (Delre, et al., 2010). Therefore, this is an important feature to consider as most adoption curves are described as a sequential process showing innovators adopting the new innovation chronologically before the rest of the groups. In fact, the different overall speeds of adoption (Day, 1981), the challenges to the simplified representation of the normal distribution applied to the adoption curve (Petersen, 1973), which for the purpose of this discussion means the curve used in figure 2.2 above showing the different categories of adopters based on time of adoption.

Confirmation and extensions of IDT theory

IDT is not the only theoretic model that has been used to describe the adoption of innovations. For example, another popular model is the Technology Acceptance Model known as TAM (Davis, 1986, 1989) and based on the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975). TAM utilizes perceived usefulness and perceived ease of use as key factors in the adoption of an innovation. Perceived usefulness refers to the degree to which a potential adopter considers the innovation to enhance performance where the perceived ease of use is the expected degree of effort that will be required use the innovation (Davis, 1989). Again, Keller's (2010) ARCS model of motivation can also apply, as relevance, confidence and satisfaction can be a factor in the perceived usefulness and ease of use dimensions. Another popular model is the Unified Theory of Acceptance and Use of Technology known as UTAUT (Venkatesh, Morris, Davis & Davis, 2003). This is a composite model drawing from IDT, TAM and six other theories and models. UTAUT identifies effort expectancy as a factor in the adoption process although it focuses on the adoption or non-adoption rather than the degree of adoption. The theories and models above mostly consider the factors in the adoption process and the adoption intention, which is the point in the decision process in which a user makes the decision to adopt, rather than adopter categories. IDT appears to be the only model that deeply embedded the concept of adopter categories.

Classifications into groups of adopters are not always seamless and a gap or chasm between individuals in the initial phases of adoption and the majority of adopters can exist (Moore, 2001). As an extension of the Rogers' IDT adoption categories model, Moore (2001) proposed a model that introduced gaps between adopter groups in the context of the adoption of high tech innovations. Moore (2001) identified the innovator as adopting an innovation for the simple pleasure of exploration, with early adopters being imaginative and appreciative of what the innovation could bring and the majority looking for more established and defined use cases. The first gap occurs between the innovators and the early adopters, where if the early adopters could not figure out how to use and apply the new innovation and it resulted in a slower rate of adoption by the early adopters (Moore, 2001). The second, much larger, gap, dubbed a 'chasm', exists between the early adopters (change agents) and the early majority (Moore, 2001). The principal reason given for this chasm was that the reference group the early majority watched are members of the same early majority cohort (Moore, 2001). Therefore, the early majority adopted mostly based on mimicking others within their own cohort. To a lesser extent, this issue of imitation was also identified for all groups except the innovators (Bass, 1969; Martinez & Polo, 1996). The third gap exists between the early and late majority and was brought on if the late majority could not overcome technical competence issues related to the innovation (Moore, 2001). Note that Moore (2001) was less focused on an academic review of the theory, and more focused on marketing and penetration to mainstream practitioners. Leveraging Moore's (2001) modified model of the adoption curve, the role of the early adopter in supporting adoption requires greater knowledge of whom and what the innovation is for. This is important as a component of bridging the chasm to the early majority involves helping move the early majority towards a more widespread adoption. Therefore, extending Moore's theory, training and education can have an important role in that process.

Key trends described by the work of Frambach (1993) regarding technology adoption have shown adoption to be positively related to the availability, quality and value of information. Complexity, uncertainty and risk are negatively related to technology adoption (Davis, et al., 1989; Day, 1981; Frambach, 1993). Additionally, when an individual is adopting an innovation in the context of an organization, as opposed to the individual adoption of an innovation, the factor of authority-driven adoption in the process (Rogers, 2003) has an important role. Authority-driven adoption is when the requirement to adopt a process, service or product is either required or recommended by those who have some form of authority. With authority-driven adoption, there exists the opportunity for authority-driven education and training such as described by Karuppan and Karuppan (2008). When the adoption is voluntary it is far more likely that the learning process follows a self-regulated learning approach. This is where the user would analyze the learning situation and set their own goals and strategies given the task conditions (Azevedo, 2009). Therefore, when looking at adoptions happening across an organization, the role of formal and informal learning is important and influential on the adoption process. This leads us to explore in a deeper way the relationship of learning described in the IDT model.

IDT and learning curves

Learning curve theory (Ebbinghaus, 1885) may be used to describe some of the factors as people adopt and learn how to use a product. Furthermore, “learning curves have a strong impact on diffusion efficiency” (Zeppini, Frenken & Izquierdo, 2013, p. 4). The learning curve refers to the capacity to ‘learn’ from repeated tasks resulting in decreased time, cost or effort in the production or use of a product or service (Ebbinghaus, 1885). We also know that a change in the adopter’s requirement for information delivery over time results in a decrease in the need for additional training and instruction (Day, 1981). Organizationally, this can refer to new or innovative products that were not previously part of an organization’s output, and as the organization improves as a result of its knowledge, it realizes benefits (Argote, 1990). Theoretical and mathematical models of various degrees of complexity exist to show this relationship, which frequently include factors such as fixed and variable costs of production, research and development spending and expected sales (Brouwer, Poot & Van Montfort, 2008; Lieberman, 1987) yet very few have been sourced that specifically investigate the cognitive aspects of learning. These cognitive aspects will be addressed in more detail in the next section of the literature review.

Additionally, learning curves also represent the ability of individuals to increase their knowledge and use of a new innovation related to IDT (Lieberman, 1987; Rogers, 2003). Multiple technologies in the same technology cluster can be adopted faster due to the transferable components of knowledge because the adoptions of innovations are not independent events (Rogers, 2003, p. 249).

A particular type of learning curve, often called an experience curve, relates the reduction in costs of production as a result of the experience effect, or in other words, less effort to get the same results is required as one moves along the experience curve (Day, 1981; Wenger and Hornyak, 1999). The unique aspect of experience, as it relates to motor skills, versus the more general learning curve, is that the experience curve is transmitted predominantly by examples, by kinesthetic delivery pedagogies, and by experiential learning (Gagne et al., 1992). Experience curves are a conceptual framework that were articulated in the 1960's and examines, among other things, the transferability of knowledge and the impact of skill development and experience on productivity (Henderson, 1968; 1984). The difference between learning curves and experience curves is that the action of activity or doing the skill is what is generating the effective benefit. In other words, the more you adopt innovations, the likelier you are to adopt a new innovation more quickly. Therefore, the concept of an experience curve can also be applied to the adoption process and the adoption groups. Other supporting evidence that a successful adoption of innovation is related to the learning curve is that some innovations require specific knowledge and compatibility with past ideas to achieve adoption of that innovation (Rogers, 1962). In fact, for an individual oriented adoption of an innovation, the UTAUT model identified one of the significant facilitating conditions is having “aspects designed to remove barriers to use” (Venkatesh, et al., 2003, p. 453). Specific knowledge and compatibility with past ideas can be some of those aspects.

One element in which the experience curve has a specific relationship to the adoption of the product is in the nature of the durability and consumability of that product. The repetitive buying nature of a consumable purchase over time is one factor on the shape of the adoption curve (Midgley, 1981). Repetitive buying dramatically decreases the need for additional training and instruction as the adopters become less responsive to information delivery (Day, 1981). This ongoing usage of the product or innovation then allows for greater retention of knowledge by the adopter (Karuppan and Karuppan, 2008), which in turn functions as a repetitive instructional effect moving the learning application downwards in complexity along the cognition scale. The broader learning curve includes all of these aspects, plus the more traditional delivery methodologies and abstract and theoretical discussions (Gagne et al., 1992).

IDT and learning curves by IDT cohort

Many studies have identified the role of the innovators and early adopters in the innovation process (Rogers, 2003; Martinez, et al., 1998). As the adoption of an innovation reaches greater cumulative saturation in the market, the extent to which the external influences is important decreases and the role of other users becomes more important (Martinez, et al., 1998). This decrease in external influence implies that the relative importance of understanding the learning curves of the earlier cohorts can be a significant factor in facilitating the learning curve processes in the latter cohorts in the adoption process. Furthermore, it has been proposed that "earlier adopters have more years of formal education than late adopters" (Rogers, 2003, p. 288) and that the better-educated person has a greater propensity to adopt innovations (Martinez & Polo, 1996; Rogers, 2003, pp. 288-290). Some studies have shown mixed, trivial or non-significant results for the influence of education (Damanpour & Schneider, 2006; Arts, Frambach & Bijmolt, 2011) while others found a positive effect (Lee, Wong & Chong, 2005; Ganter & Hecker, 2013). However, if innovators in the Roger's IDT classification scheme adopt more technologies the application of the learning curve for an innovator possibly could show a different shape and/or rate of adoption than other cohorts in the adoption classifications.

Karuppan and Karuppan (2008) and Moore (2001) highlight the role of the super-user (early adopter) in the cascading of knowledge to the larger (early and late majority) adopter cohorts. Karuppan and Karuppan (2008) specifically linked the connection between the super-users role in the adoption of an enterprise-wide system and their role in the instruction to the majority. This role connects with the principle that the innovators and early adopters are opinion leaders (Rogers, 1962, 2003) and have ability to persuade, and later assist, the majority in implementation. Understanding that learning has a role in the adoption process, we now can examine what IDT literature has brought forward about education and training (both formal and informal) as a mechanism to enable the learning process.

IDT, training and education

Long before the interest in present-day social media and social learning research, IDT was identified as having a social process component (Rogers, 1981). Since then, others have echoed this social learning process as part of the changing values and willingness to adopt (Brown, 1992). Additionally, some research suggests that “the diffusion phase enlarges due to learning” (Zeppini et al., 2013, p. 21) and one way this happens is that the speed of adoption is impacted by the transmission and reception of information (Brown, 1992; Martinez, et al., 1998). While training and education can be part of any stage of IDT (refer to Table 2.1), they typically are most often associated with the implementation stage of Rogers' IDT process (De Leede & Looise, 2005; Damanpour & Schneider, 2006; Ensminger & Surry, 2008). Specifically, the nature of education versus the nature of awareness makes this training component more important in the implementation stage of the adoption process because the role of usage and the perception of value will greatly help to prevent discontinuance (Ensminger & Surry, 2008; Rogers, 2003; Moore, 2001). Most change agents promoting adoption focus on awareness by using "opinion leaders in a social system as their lieutenants in diffusion activities" (Rogers, 2003, p. 27). They often leave other parties to handle formal education and use questions and to intensively influence the innovation decision (Rogers, 2003, p. 38 & 173).

The innovator might ignore poor documentation but the early adopters, identified as visionaries, are more product-use oriented. The early and late majority and will desire training and education over experimentation (Moore, 2001). Historically, training has a limited role with laggards usually only to neutralize their skeptical nature that could influence discontinuance of the adoption (Moore, 2001).

Some consideration of the instruction of late bloomers (those that exhibit a delayed period to understand and synthesize) and late starters (those that are exposed at a later chronological time than the majority) and the differences that these later groups exhibit is useful (Yew, 2009). In an era of standardized tests, instructional metrics and school system performance expectations, educational pedagogy has frequently considered the cohort of students that struggle with learning new concepts (who may be considered the laggards), exploring and exploiting different methodologies to advance their development (Yew, 2009; Zohar & Dori, 2003). Many product adoption champions ignore the laggard's needs or requirements from an IDT perspective because the tail end of the learning curve is usually associated with the decline of innovation (Abernathy & Wayne, 1974) and the numbers of laggards are relatively small according to the distribution model of Roger's (2003). Therefore, there are opportunities to consider the learning curves of late majority and the laggards. In the next section, critiques about bias against the late majority and laggards are identified. Overall, the consensus from publications on this topic is that there are stages of adoption and the nature of usage by members in those groups will vary. The connection between the field of business and the field of education is clear in IDT. Thus, knowledge and cognition can be applied to each of the stages of the learning curve for each cohort in the innovation curve, as each cohort adopts and then integrates the use of the new innovation.

Critiques and gaps identified in the IDT research

Even in its early years the IDT model has been well-examined and critiqued with varying results (Downs & Mohr, 1976; Miller & Friesen, 1982).

> Perhaps the most alarming characteristic of the body of empirical study of innovation is the extreme variance among its findings, what we call instability. Factors found to be important for innovation in one study are found to be considerably less important, not important at all, or even inversely important in another study. This phenomenon occurs with relentless regularity. (Downs & Mohr, 1976, p. 700)

For example, similar to the challenges against the smooth and simplistic nature of the product life cycle (PLC), there have been challenges to the simplified normal distribution of the adoption curve (Petersen, 1973). Therefore, it is worthy for us to explore the possibility that different groups of adopters in the technology adoption cycle could also have unique characteristics in the shape and rate of their group learning curves as part of the adoption process. Furthermore, a potential gap in IDT theory is the frequent reliance on a normal curve, time-based, method of classifying adopters into categories. Categorization and population sizes of the various groups of adopters has been a contentious issue in the IDT model and have been examined, and adjusted, both conceptually and mathematically to more accurately represent observable distributions (Martinez & Polo, 1996; Martinez, et al., 1998; Petersen, 1973). Another additional critique of IDT is the impact of the cyclical nature of the general economic cycle of the marketplace as a whole (Azadegan & Teich, 2010; Day, 1981).

One of the principal critiques acknowledged by Rogers includes a *pro-innovation bias* (Rogers, 1981, 2003; Straub, 2009) which is that an assumption exists that the innovation should be adopted and will have a positive benefit without necessarily being true. Relatively few studies look at those adoptions that should not be adopted (Rogers, 2003). Studies have been done on those innovations that started or failed but not usually through the lens that the innovation ought not to be adopted (Rogers, 2003). A second particular critique of IDT research that is tied to the educational component is the *individual blame bias* against late adopters and laggards (Rogers, 2003). The stereotyped characteristic of those two groups (late majority and laggards) are that they are uneducated and education, intelligence, rationality and literacy accelerate the adoption process (Rogers, 2003). Additionally, it is important to differentiate laggards from non-adopters as many of those that do not adopt think that the innovation does not best apply to them (Vanclay, Russell & Kimber, 2013). This is one of the critiques levied against the concept that innovators and early adopters are more likely to be better educated. According to Cheney, Mann and Amoroso (1986), training and education is a fully controllable variable relative to end-user computer use and, as a result, they recommended more research into the impact of training and education on adoption.

Straub (2009) recommended research on other models of adoption in educational settings. Some work was undertaken by McAlearney, Robbins, Kowalczyk, Chisholm and Song (2012) in investigating the role of cognitive and learning theories in electronic health record system implementation training. They found that different communities of practice have different training needs and that champions and role models are valuable in facilitating adoption. However, without fully using learning theories in a comprehensive form they recognized that their study was not designed to assess the relationship in a definitive manner (McAlearney, et al., 2012). Furthermore, while Bostrom, Olfman and Sein (1990) discussed the influence of learning styles on end-user training, more recent literature has questioned learning styles theories (Pashler, McDaniel, Rohrer & Bjork, 2008; Romanelli, Bird & Ryan, 2009) and the extent to which they can be applied.

Further, early IDT research focused predominately on the adopter side of the IDT factors and largely ignored the supplier influences (Frambach, 1993). Frambach (1993) further identifies that this supplier support role was not well integrated into the IDT model. However, more recent work has investigated the influence of experiential diversity that suppliers bring to the innovation adoption process (Weigelt & Sarker, 2009) and on the effect of supplier and customer integration on product innovation and performance (Lau, Tang & Yam, 2010). However, Lau, Tang and Yam (2010) contend there are still opportunities for more refined research in this area. It is important for us to explore the role of the educator and trainer and the degree of influence that formal and informal learning has on the adoption curve or the degree to which training or learning is part of the adoption process. While

Rogers' (1962) initial work treated the communication aspect as mostly one way, his later works identified the two-way aspects of communication (Rogers, 2003). Where there has been a focus on supplier side activity it usually deals with the general awareness variables and the efforts to reduce perceived risk (Day, 1981). After-sales service support can enhance the adoption process and reduce the likelihood of discontinuance (Day, 1981). The lack of understanding of why an innovation works can be a barrier to full adoption or even increase the misuse of the innovation (Rogers, 2003). In fact, the specific role of education and the amount of diffusion research related to the educational effects was noted as a gap by Rogers (2003) and few diffusion investigations deal with the how-to component of the knowledge transfer process. Organizational adoption could benefit from more studies related to education's role in the diffusion of innovation process, and even the diffusion of innovations in educational settings (Rogers, 2003). Furthermore, much of Rogers' IDT framework is descriptive in nature as opposed to how to accelerate adoption (Straub, 2009).

Implications of IDT and section summary

As seen in this section of the review of the literature, many studies have identified the role of innovators and early adopters in the overall diffusion process. However, there are a number of additional implications, such as the laggards increased likelihood of discontinuance due to disenchantment or difficulties in using the new innovation (Rogers, 2003). This makes providing these trailing groups in the cycle with adequate training and support important when they adopt.

The distinct characteristics of the majority also represent a key implication if there is a variance in their learning curves. Just as the innovators have their role and the laggards their effect, the majority is key to obtaining a critical mass to make the diffusion process self-sustaining (Moore 2001; Roger, 2003). After the diffusion is seen as self-sustaining, the death stage of the PLC (Fig 2.1) curve can be brought on if a critical mass of adopters discontinues implementing the innovation. How the two majority groups function in the learning curve can impact the stabilization and diagnose problems thus preventing discontinuance (Rogers, 2003). One solution for technology adoptions that enables bridging the chasm in the adoption cycle theory is by taking a whole product approach (Moore, 2001) that goes beyond just the base generic product. For example, in the case of a technology innovation, a whole product approach includes; integration into the larger system, other hardware or software, the standards and procedures, installation and debugging, cables, and also, according to Moore (2001), training and support. More recently, with the organizational adoption of enterprise-wide information technology systems, there has been an increased interest in the role of training and education (Cheney, et al., 1986; Palvia, 2000; Karuppan and Karuppan, 2008). While IDT acknowledges the role of learning in the innovation adoption process, it does not fully explain that role nor examine its influence within the context of the body of knowledge related to learning. One approach is to examine the learning process in a structured way using a learning taxonomy model. The next section of the literature examines in greater detail the literature on learning taxonomies and how it enhances our understanding of learning in the adoption of an innovation.

Learning Taxonomies

This section of the literature review examines existing literature on the general principle of taxonomies and the challenges that may exist with such taxonomies. It highlights one of the first and most commonly used learning taxonomies, known as Bloom's taxonomy (BT), as well as an established extension known as Bloom's revised taxonomy (BRT). Next it reviews the differences between the two versions, and then it identifies the literature's perspective of the role of meta-knowledge and knowledge transfer. Opportunities and challenges relating to use of BRT are reviewed, and then a review and rationale for selection of a learning taxonomy concludes the section.

Introduction to taxonomies and potential issues

According to McCarthy and Tsinopoulos (2003) the use of frameworks is popular to understand the structure, relationship and behaviour of a phenomenon. A framework provides a structure to examine key characteristics and components that define a system (McCarthy & Tsinopoulos, 2003). The development of a taxonomy includes the forming and naming of groups (McCarthy & Tsinopoulos, 2003). According to the literature, a taxonomy and a typology are different in that empirical classifications yield taxonomies and theoretical classifications yield typologies (McCarthy & Tsinopoulos, 2003; Meyer, Tsui & Hinings, 1993). In particular, the empirical evidence used to form a taxonomy collects and processes evidence using numerical tools (McCarthy & Tsinopoulos, 2003). However, there is no one consistent way to structure all of the possible variations and forms of a taxonomy, yielding the first issue with taxonomies, diverging approaches.

While categorization through taxonomies and typologies is useful, Meyer et al. (1993, p. 1181) warns against “atomizing” essential interconnectedness as some classification schemes oversimplify and do not appropriately reflect the complexity. This balance is important since “as dimensions are added to increase congruence with reality, configurations necessarily grow more complex and unwieldy” (Meyer et al., 1993, p. 1182). Meyer et al. (1993) imply that if there were a perfect taxonomy, it would not replicate reality but would generalize and abstract. This yields the second issue, unwieldy subdivision.

Classifications can be social constructions and fit a social cognitive process connection (Meyer et al., 1993). Furthermore, McCarthy and Tsinopoulos (2003) identify that you would not be able to understand the whole system by just reducing the system into parts and that a system is complex and adaptive with rules at the individual and systemic level. This yields the third issue, uncertainty due to complexity. Understanding the premise and potential issues of taxonomies in general we now explore learning taxonomies specifically.

Introduction to learning taxonomies

Educational research and pedagogy have been influenced by a number of key theories and frameworks. According to Neumann & Koper (2010), one of the most widely cited and influential of those educational frameworks is Bloom’s taxonomy (Bloom et al., 1956). A Google web search on April 29, 2015 results in over 569,000 hits for “Bloom’s taxonomy” and a Google scholar search resulted in 39,400 hits. This taxonomy will be referred to in this work as BT. Bloom’s taxonomy has been translated into over twenty languages (Anderson & Krathwohl, 2001) and by 1981 was tied for the fifth most influential educational writing (Shane, 1981). This fundamental framework (BT) was revised by Anderson and Krathwohl (2001) and their revision will be referred to in this work as Bloom’s revised taxonomy or BRT.

Notwithstanding the widespread acceptance of BT and BRT in educational circles, other frameworks related to learning also exist. Gagne and Briggs’ (1974) instructional decision-making model listed nine events to undertake in a learning process (see Appendix A1) (Gagne et al., 1992). Their research identified that not all events needed to be accomplished in each learning lesson, nor was it required to be followed sequentially, but can be implemented in a flexible manner (Gagne et al., 1992). However, Denton et al. (1980, p. 12) demonstrated how these instructional events could be cross-referenced to the original BT. Denton et al. (1980) expressed four steps in an instructional event process as 1) determine the cognitive level, 2) develop a pattern of instructional events, 3) select the instructional technique to fit, and 4) identify the sequence to achieve the identified events.

The structure of observed learning outcomes (SOLO – see Appendix A2) is another taxonomy that was developed by Biggs and Collis (1982) and then applied by Lucas and Mladenovic (2009) to accounting. SOLO was rooted in Piagetian styles of development theory (Biggs and Collis, 1982). Lucas and Mladenovic (2009) chose SOLO because it accounted for different knowledge structure that led to the same behaviour and its taxonomy facilitated determining depth as well as frequency of learning. Another advantage they attributed to SOLO was the transitional stages between categories (Lucas & Mladenovic, 2009).

In addition to different taxonomies many adaptations of BT also exist. For example, between the years of 1978 and 2008, Dick, Carey and Carey (2008) expanded BT into four main learning domains and re-categorized them as verbal information, intellectual, psychomotor, and attitudes. Saroyan and Snell's (1997) classification focused predominantly on lecture styles classification and identified the frequent critique regarding lecture methodology in failing to promote higher order learning. Overall, many frameworks for learning taxonomies or instructional design systems exist.

Classifications or configurations are often represented as either an empirically developed taxonomy or a conceptually created typology (McCarthy & Tsinopoulos, 2003; Meyer et al., 1993). Neumann and Koper did a review of thirty-seven learning classification schema and for their purposes stated "instructional method is defined as a learning outcome oriented set of activities performed by learners and learning supporters" (2010, p. 78). Their goal was a versatile and reliable instrument to review and compare the schema (Neumann & Koper, 2010). They founded their literature review on three research questions: a) what classifications already exist for learning and teaching, b) how and for what purpose the classification was created, and (c) whether the classification criteria meet a quality benchmark for being an instrument that will organize instructional methods (Neumann & Koper, 2010).

They obtained the thirty-seven different classification schemas through a literature search that included Google Scholar searches and database searches. They assumed that citation rate was an indicator of usage frequency or acceptance rate (Neumann & Koper, 2010). Furthermore, Neumann and Koper (2010) concluded that only a handful of learning taxonomies seemed to be used with any real frequency, one of which was BRT, cited about 10 times as often as others. As of an April 7, 2015 Google Scholar web search, BRT has been cited over 6900 times.

In the analysis by Neumann and Koper (2010) the classifications were ultimately divided into three major groups: narrow focus, holistic focus and versatile focus, which, they believed could be used to later include and rate additional classifications that might arise. Only six of the 37 classifications met their standards and were related to their three research questions listed above. Their hurdle was to meet at least two of the nine validation criteria (see Appendix A3 for the nine criteria they employed from Lambe, 2007); in fact, none of the six filled more than three criteria (Neumann & Koper, 2010). However, Neumann and Koper's (2010) conclusion stated that the construct of the method of selection, or the field of study, would make it unlikely for any classification scheme to meet many of the criteria they had. Additionally, they felt BRT could potentially meet at least one other criterion depending on measurement factors (Neumann & Koper, 2010). Neumann and Koper's (2010) final conclusion was that the construction of a good classification system was still in its infancy even after fifty-plus years since the original BT.

Blooms' taxonomy

An important component of reviewing the incorporation of BT in this research on the interface between BRT and IDT is to understand the process in which BT was created, refined and published. Understanding the practical application that BT was developed for helps us understand its strengths and weaknesses in context. Bloom's Taxonomy (BT) was developed over a number of years by a committee of educational examiners focused on the general and secondary levels of education with other educational researchers and professionals contributing to that work which culminated in the 1956 publication (Bloom et al., 1956) which focused on the cognitive domain. Their original focus was to examine educational objectives intending for the students or learners, to "really understand", to "internalize knowledge" and to "grasp the core or essence" (Bloom et al., 1956, p. 1). They also sought to be able to contrast any particular course or program against a range of possibilities (Krathwohl, 2002). BT came from a measurement based focus that emphasized behavioural exemplars of the student learner and attempted to classify phenomena that usually could not be directly observed or manipulated (Bloom et al., 1956). Bloom et al. (1956) divided learning objectives and outcomes into three large groupings:

- cognitive – the development of intellectual skills and abilities,
- affective – interests, attitudes and values, and
- psychomotor – manipulative or motor skills.

While the cognitive domain is the most established (see Appendix A4 for full description), Bloom and others have created additional descriptors for the affective and psychomotor domains. One of the listings for additional descriptors of Bloom's Taxonomy three learning domains is provided in Table 2.3 below (Odhabi, 2007).

Table 2.3 *Descriptors for BT learning domains (Odhabi, 2007)*

Cognitive	**Affective**	**Psychomotor**
Knowledge	Receiving phenomena	Perception
Comprehension	Responding to phenomena	Set
Application	Valuing	Guided response
Analysis	Organization	Mechanism
Synthesis	Internalizing values	Complex overt response
Evaluation		Adaptation

Historically, the most common usage of Bloom's taxonomy comes from *Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain* by Bloom et al. (1956) which focused on cognitive skills. Handbooks for the other domains were not developed by Bloom et al. at the same time mostly because of the challenge in explaining, categorizing and measuring the affective and psychomotor sets of learning objectives. Later, others also identified the attitudes, which compare to the affective learning domain in BT, as difficult to instruct or design (Dick et al., 2008). One of the original intentions of BT was to keep in harmony with teacher- / educator- based distinctions that had consistency with the psychology principles of the day rather than using the actual psychology related frameworks (Bloom et al., 1956). Bloom et al. (1956) intended to ensure that the value of the taxonomy would be realized in its use. Bloom et al. (1956) desired that the taxonomy that would result would not be preferential to certain subjects and classes and would be logically and internally consistent.

Bloom et al. (1956) gathered a list of 200 objectives from different courses and educators and examined the intended behaviour versus the content and began to group the objectives by cognitive process. They recognized the difficulty of classifying intended behaviour when the actual result may differ (Bloom et al., 1956). They identified a few other constraints: first, some objectives may have the same appearance but be different; second, others may have a different appearance but be the same; and third, they also identified that the interface of different objectives are more complex than the aggregation (Bloom et al., 1956). Note, as a process rule, Bloom, et al. (1956) would, by default, place an objective in the most complex cognitive class when it appeared in multiple areas in the taxonomy. They defined six major classes: *knowledge, comprehension, application, analysis, synthesis* and *evaluation*. There were over twenty sub-categories that fell out from the six major classifications (see Appendix A4). This was built upon a premise that the taxonomy increased in complexity and that you would need to accomplish the lower order classes before the higher order classes (Bloom et al., 1956). They also believed that the learner was more conscious of the learning objective as you moved upwards along the taxonomy and that it was easier to answer assessment items of a lower order (Bloom et al., 1956, Krathwohl, 2002). Using a scatterplot of test results on the various question types as their evidence for complexity they corroborated the trend, without being entirely satisfied (Bloom et al., 1956). Adding additional learning objectives, and then classifying them into the major groups, the development team for the taxonomy tested for consistency with each other (Bloom et al., 1956). They also looked to ensure transferability across fields while still being something the committee could see being accepted by practitioners (Bloom et al., 1956).

Handbook one of BT was intended as a working book for the reader to classify objectives for instructional assessment items such as tests and to evaluate the learner for the degree or depth of cognitive process employed. BT became a foundational framework for testing worldwide (Anderson and Krathwohl, 2001). The handbook provided major definitions, objective list definitions and then illustrative examples. Even our process of a doctoral dissertation today follows a rough alignment of BT from the literature review through to the research and writing phases. Bloom et al. (1956) saw the importance of motivation at the synthesis stage and their rationale to place evaluation at the end was that evaluation required the lower order components to be done first. As a result, BT is rooted in some positivist fundamentals and subscribes to principles of accuracy, internal standards, external standards and the dangers of bad synthesis (Bloom et al., 1956). BT was taught and promoted as fundamental for nearly 50 years as part of Bachelor of Education programs and other educational related curriculum and instruction fields. However, in 1994, Lorin Anderson, a student of Bloom, and some of the original authors set about to revise the taxonomy and improve its relevance and currency in light of new knowledge in the fields of psychology and education. This materialized in BRT (Anderson and Krathwohl, 2001) and is described in detail below.

Blooms' revised taxonomy

Anderson and Krathwohl (2001) engaged a large multi-disciplinary contributor team between 1995 and 2001 and sought to recharge BT by incorporating new knowledge and thought. Their goal was a revision that had an improved common language and would be consistent with changes in psychology and education (Anderson & Krathwohl, 2001). Additionally, the revision incorporated the findings of numerous journals, articles and publications between 1956 and 2000. Their revised taxonomy was published in a complete form and an abridged form. Similar to the original handbook, it was full of examples on how to use the framework and was intended to support practitioners. Heavily borrowing from the original BT, it is significant to note that two of the main authors involved in the original BT, Dr. Edward Furst and Dr. David Krathwohl, as well as two other contributors of the original, Dr. Christine McGuire and Dr. Nathaniel Gage provided various levels of contribution into the revision (Anderson & Krathwohl, 2001).

There are a number of key theoretical underpinnings and perspectives within the new taxonomy. Anderson and Krathwohl (2001) recognized the idea that *behaviour-as-a-result-of-instruction* and how that was evidenced in 2001, was different than the predominant psychological learning theory of '*Behaviourism*' during the time period of the original taxonomy. However, this similarity between *behaviour-as-a-result-of-instruction* and the learning theory of '*Behaviourism*' was blurring what was originally intended by the authors of BT. Behaviourist theory is based on a principle that an observable change in learner actions, prompted by the educator and then reinforced, promotes learning (Crescente and Lee, 2011), and that learning is linear and sequential (Zohar and Dori, 2003). However, BT was supposed to be more than a means to achieving an end, or a manipulation and control-based framework. Despite this, the original taxonomy was influenced by the *management-by-objective* thinking of the time (Anderson & Krathwohl, 2001). Thus, replacing behaviour with cognitive process was an important aspect of the revision by Anderson and Krathwohl (2001). By the time of the publication of the revised taxonomy, cognitive psychology was a dominant perspective in education and incorporated new foundational theories of learning (Anderson & Krathwohl, 2001). Another underpinning drawn out by Anderson and Krathwohl (2001) was the emphasis on a student point-of-view which included the panorama of possibilities, such as metacognitive knowledge, and learning how to learn. Additional reasons for the creation of the revision included the relationship between the knowledge dimension and cognitive processes, the wide variety of terms available, and the examination of mutually exclusive, unique entities (Anderson & Krathwohl, 2001). In particular, Anderson and Krathwohl (2001) highlighted the constructivist process of *making sense* embedded in this core review of the knowledge and cognitive dimensions. Crescente and Lee (2011) state that the developing of new ideas based on current or prior knowledge is very much constructivism and occurs perpetually in both a conscious and subconscious way. Thus, Anderson and Krathwohl (2001) included a now more traditional, rationalist-constructivist perspective of the knowledge organization and structure. Next, we will highlight the core differences between the original BT and the newer BRT.

Core differences between BT and BRT

One of the key objectives in the goal of the revision was to recognize the increasing trend towards standards in education at the district, ministry and other levels (Anderson & Krathwohl, 2001). Anderson and Krathwohl (2001) wanted to ensure that they retained a continuum for the taxonomy to be framed upon. Previously Denton et al. (1980) noted the increased focus on standardized tests and the trend was becoming increasingly common. The changes in the revised taxonomy compared to the original one are summarized below (Anderson & Krathwohl, 2001, Krathwohl, 2002):

- Restating/renaming the categories within the taxonomy in verb form (see Figure 2.3)
- Reordering the last two levels of the taxonomy (see Figure 2.4)
- Moving to a two dimensional structure separating the noun component of knowledge from the cognitive component and development of a row-cell taxonomy table (see Appendix A5 and Figure 2.4)
- Recognizing the movement towards a more constructivist frame than a positivist frame
- Focusing even more on the taxonomy in use (practitioner focus)

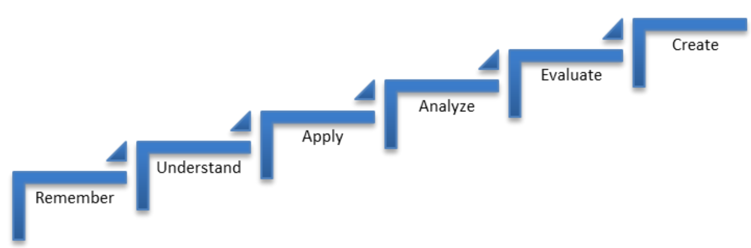

Figure 2.3 Categories of Bloom's Revised Taxonomy (adapted from Anderson & Krathwohl, 2001)

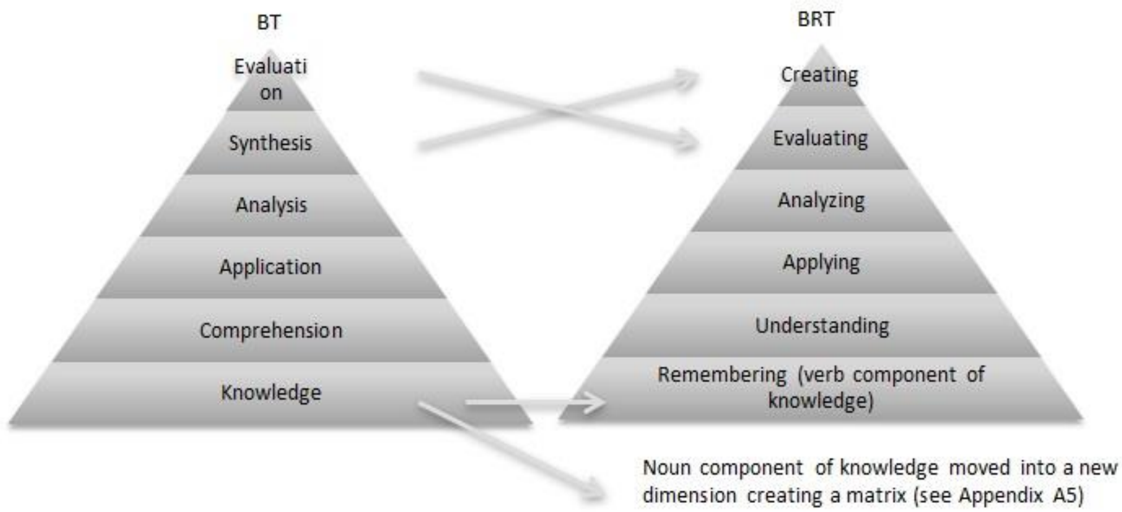

Figure 2.4 Changes in BRT compared to Bloom's Taxonomy (adapted from Krathwohl, 2002)

Each of these changes offers advantages in general, as well as specifics for assisting in the understanding the adoption of innovations. First, the changes to a verb form are beneficial because they are a better fit with the active nature of an innovation adoption process. Second, moving creating to a later stage than evaluating is more parallel to the five stages of adoption identified by Rogers' (1962) where persuasion and decision precede implementation and confirmation. Third, the opportunity to separate knowledge from cognitive dimensions adds an additional lens through which to view a learning event process. Fourth, by acknowledging a constructivist frame allows for greater sense-making, especially in the context of a practitioner focus. These adjustments addressed some of the most significant challenges in the application of BT over the preceding forty years. They allowed the value of the taxonomy to be enhanced for the complex topic of learning and learning outcomes.

Meta-knowledge & knowledge transfer components within BRT

An important component of the revised taxonomy in relationship to this intersection of IDT and the role of learning is the meta-knowledge component. In BRT the additional factor of meta-knowledge emphasized the control of our own cognition and our self-awareness (Anderson & Krathwohl, 2001), while Bransford, Brown and Cocking (1999) identified that we learn better as our meta-knowledge increases (1999) and Flavell (1979) identified that strategies to learn occur via meta-knowledge. Measuring meta-knowledge is a challenge and while strategic rehearsal, elaboration, organization, planning, monitoring, and regulating cognition are all indicators according to Anderson and Krathwohl (2001), it is a developing field to assess this level of self-awareness. This raises issues for future consideration. Meta-knowledge can be demonstrated when applying different strategies to different situations and is a unique aspect to measure in a taxonomy (Anderson & Krathwohl, 2001; Barak, 2010). Remembering that the original taxonomy, and the revision, are intended to serve a practitioner audience, usually as part of assessment or evaluation support, it is problematic to identify “correct” meta-knowledge and this is a potential issue of interpretation (Anderson & Krathwohl, 2001). Here is one area where classification is not as simple as BT originally implied and has deep implications to the exploration of the role of learning in the adoption of innovations.

Another core component embedded in the findings and presentation of BRT is the development of understanding around knowledge transfer. Over the years between the original and the revised taxonomy, debates regarding knowledge versus subject matter content occurred (Anderson & Krathwohl, 2001). The revision's approach of using verbs to connect 'what we want learned' versus 'how to demonstrate learning' is part of this knowledge transfer (Anderson & Krathwohl, 2001, p. 14). Potentially even more important is transferring learning to new situations (Anderson & Krathwohl, 2001; Bransford et al., 1999; Barak, 2010). According to Anderson et al. (2001), transfer is a deeper cognitive related process than retention, wherein transfer makes sense of, and is able to use, knowledge in many other situations. BRT was intended to assist with transfer issues, especially by re-examining the five higher order categories in the cognitive process within a context of constructivist learning (Anderson & Krathwohl, 2001). Furthermore, Anderson and Krathwohl (2001) identified that one important corollary is that transfer does assist with long-term knowledge retention.

Opportunities and challenges with BRT

Notwithstanding the numerous improvements that BRT brings to the original taxonomy, the development of the field also coincides with an increased critical reflexivity by the authors of BRT. This has resulted in the identification of a number of opportunities and challenges. Some opportunities reflect the ability of practitioners to maximize their time in the learning process, reducing repetitive lower-order approaches in the learning process, performing a gap analysis of the distribution of objectives within the BRT taxonomy table, and considering more effective use of parallelism in assessment (Anderson & Krathwohl, 2001). Furthermore, Anderson and Krathwohl (2001) provide a possible methodology to deal with the scope of global, educational and instructional objectives which could reduce the time frame required by practitioners to design and apply assessments. Many practitioners have benefited from the taxonomy assisting with the processes of identifying and aligning learning, instruction and assessment outcomes (Anderson & Krathwohl, 2001). This is important as Anderson & Krathwohl (2001) propose that at the intersection of knowledge and process greater student learning is likely to result. However, the taxonomy does have its weaknesses and challenges. While they are not crippling or insurmountable, they need to be recognized and acknowledged in the application of the taxonomy. BRT does a better job than BT in identifying and addressing the challenges listed below:

Mechanical and relative challenges: Anderson and Krathwohl (2001) first identified the stating of objectives are not equally easy in all areas or possible topics of study; second, many of the simple illustrative examples are not representative of overall difficulties; third, ambiguity within the verb forms is a potential issue; and fourth, classifying involves inferences which can lead to potential disagreements between those categorizing.

Hierarchy and order challenges: While the taxonomy is a relative hierarchy advancing from level to level, it is not conclusively cumulative, but the general complexity does hold true as you move up the taxonomy (Anderson & Krathwohl, 2001). They note that the data did not support the ordering of classes at the higher order cognitive processes as strongly as it did at the lower order cognitive processes (Anderson & Krathwohl, 2001).

Unclassifiable category challenges: Some other challenges are a result of the decisions to leave problem solving and critical thinking out of the explicit taxonomy (Anderson & Krathwohl, 2001). This is based on the decision that problem solving and critical thinking can cross multiple categories in the classification at both the knowledge dimension and the cognitive process dimension (Anderson & Krathwohl, 2001). Later, Barak (2010) looked to identify some solutions to the problem solving / critical thinking aspect by using the idea of self-regulated learning. Therefore, BRT to some extent is covering that gap essentially by using the metacognitive knowledge factor in the knowledge dimension.

Implications of BRT and section summary

Learning taxonomies present a formal way to examine the role of learning in the context of this topic of innovation adoption. This section of the literature review examined a number of possible frameworks. While no single learning taxonomy covers all possible aspects of an ideal taxonomy a few of these offer a more comprehensive approach (Neumann & Koper, 2010). The seminal work by Bloom, et al. (1956) identifies three domains: cognitive, affective and psychomotor. Within the cognitive domain Bloom et al. (1956) provides a loosely progressing hierarchy of cognitive thinking. The subsequent revision that created “Bloom’s Revised Taxonomy” (Anderson & Krathwohl, 2001) provides additional perspective with a knowledge dimension and a cognitive dimension. However, despite the challenges that exist with these taxonomies there is an opportunity to use these frameworks to explore the connection between innovation adoption and the role of learning.

The Connection between IDT principles and BRT principles

While the literature does not reveal explicit studies connecting IDT and BRT there are a number of linkages that can be identified. One of the many factors involved in Rogers' innovation diffusion theory (IDT) is that of knowledge transfer. Unfortunately, IDT does not address in a rigorous way the role of learning to enable the knowledge transfer. BRT looks at the cognitive progression in learning but not through the lens of innovation adoption. It is this idea of knowledge transfer in IDT that connects to the research in knowledge and cognitive processes (BRT). Through connecting BRT and IDT it is possible to gain greater knowledge and guide opportunities in practice. A number of studies have explored various aspects of this relationship.

Barak (2010) connects a variety of IDT principles to learning theory. He brings in authentic learning, project-based learning, and problem-solving learning to a technological situation (Barak, 2010). Furthermore, Barak (2010) discusses how technology assists in accessing information, communicating information, making decisions regarding learning goals, choosing strategies, and receiving feedback – all forms of communication that can be captured in the categories of BRT. Finally, it is also important to recognize that "with more complex or difficult systems, ease of use may have had a greater impact on intentions" thus further linking the connection between BRT and IDT (Davis et al., 1989 p. 999).

Crescente and Lee’s (2011) article on m-learning (mobile learning) is another example of an effort to link educational taxonomy work to the adoption of an innovation. Crescente and Lee (2011) also discuss both BT and IDT in the process of adoption of the new learning format as well as exploring links to the works of Dick et al. (2008). However, most of the work by Crescente and Lee (2011) is about using a technology to learn rather than learning to use a new technology. With respect to their work, it is recognized that the objective to learning how to use the technology in order to then later use the technology to learn something is important. It is through this connection that Crescente and Lee (2011) referenced Roger’s IDT theory and identified the adoption of mobile technologies.

Odhabi (2007) looked to see how BT and other related theories interfaced with technology adoption and usage, by examining the impact of laptops on student learning. Odhabi (2007) recognized all three of the learning domains from BT (cognitive, affective and psychomotor) were involved. The results indicated favourable connections with the cognitive and psychomotor domains, but not as favourable for the affective domain (Odhabi, 2007). Odhabi’s (2007) conclusion was that other methods would be required for relevant connections to the affective domain.

Salisbury (2008) investigated the idea of collaborative knowledge creation within a newly adopted process and also investigated if a framework could be applied. He noted a problem with ensuring the “right knowledge that needed to get to the right people at the right time” (Salisbury, 2008, p. 214). In particular, Salisbury (2008) identified that for a new process, many employees were being asked for the first time to subscribe to a particular business practice and as a result Salisbury (2008) looked for the relationship to BT. Specifically, he was interested in the "phase of collaborative knowledge creation in the lifecycle of knowledge" and transferring of knowledge in the collaborative setting (Salisbury, 2008, p. 216). Crescente and Lee (2011) support the idea that a collaborative model of knowledge is created when experiences are shared. Salisbury (2008) leveraged BRT in the theoretical foundation of his model and, in particular, applied the metacognitive knowledge component as well as the knowledge and cognitive process dimensions. One unique relationship from Salisbury (2008) was how he related the lower levels of the knowledge dimension to be more weighted to an explicit knowledge and the higher levels of the knowledge dimension as a tacit knowledge. The concept of explicit knowledge is also discussed by Barak (2010) in his review of the literature. Furthermore, Salisbury (2008, p. 221) was very practitioner focused and examined the process in which practitioners become experts and provide access to meta-knowledge to others in the organization. Interestingly, his model explored how experts would convert tacit knowledge to explicit knowledge before transferring that knowledge to others in the organization (Salisbury, 2008). This fits Anderson & Krathwohl's (2001) position that, as learners advance, skills that were once complex orders of cognitive process become a more simple cognitive process. Another study showed that computer software education incorporating components of Bloom's taxonomy (recall and comprehension) introduced to non-segmented convenience cohorts identified an S-shape learning curve (Palvia, 2000).

BRT identifies that experts know a lot, have organized knowledge, and are considered to have exhibited “deep learning” (Anderson & Krathwohl, 2001, p. 42). A concern raised by Zohar and Dori (2003) is that higher order cognitive learning should not be restricted to only the advanced learners. Their research shows that low-achieving students can benefit from higher order thinking skills as much as the high-achieving students (Zohar and Dori, 2003). This is a key finding as it relates to the connection between BRT and IDT in that the innovators and early adopters may not necessarily demonstrate the higher order cognitive processes any more frequently than the later adopters in the IDT classifications. Zohar and Dori (2003) collected qualitative data showing that educators were biased believing that low-achieving students could not benefit from the higher order thinking skills as much as those who had mastered the lower order skills and were considered high achievers. Zohar and Dori (2003) objected to the hierarchal nature of BT but did appreciate the clear and succinct usefulness of the taxonomy. They felt that if all learners were not exposed to higher order skills the gap between high and low achievers could become wider (Zohar and Dori, 2003) and this could, by inference, be a factor in adoption groups via IDT. In fact, according to Zohar and Dori (2003), traits often associated with experts who most usually are associated with the innovators and early adopters in IDT, were demonstrated by the low-achieving students. The gap between the high and low groups decreased when both are using higher order thinking (Zohar and Dori, 2003). A tangential point of view is that higher-order instruction cannot take place in isolation from all four levels (factual, procedural, conceptual and meta-cognitive) of the knowledge dimension of BRT

(Barak, 2013). Therefore, a key area to investigate is whether or not the existence or frequency of higher order cognitive activities is correlated to the degree of innovativeness.

To summarize, over the past ten years an increasing interest, as determined by these studies, in the connection between innovation adoption and learning exists. We have evidence and a body of research that shows learning influences the adoption of an innovation. We also know that the rate and degree of adoption is connected to cognition. We know that there are hooks and connections between IDT and BRT. We have limited detailed examination of these links. Ultimately, the benefit of better understanding the connection between the knowledge influence on the adoption process and how people operate through levels of cognition via BRT can help us understand how to facilitate adoption of an innovation. Thus, this review of the literature is foundational to the connection of the interfaces between BRT and Rogers' IDT.

Summary of Literature Review

In this research of IDT and BRT a number of important issues exist. As a general line of inquiry, many questions could be explored – e.g., how do people learn and then use new technologies? Does the nature of the learning and implementation of the new technology change based on the stage of the product life cycle? What roles do learning and experience curves have in the nature of the adoption? How can these factors be employed to best design a methodology to accelerate the successful adoption of technologies in an organization? How does the shape of the learning curve differ between one adopter cohort and another adopter cohort? The exploration of all the above possibilities is beyond the scope of this dissertation. Fortunately, some have been, or are being investigated by other researchers. In the above synthesized review of IDT and BRT most of the related research has identified the instructional relationship of outcomes to the adoptions of an innovation.

While there are a vast number of factors identified in IDT that influence adoption, one of these, i.e., the role of learning in the innovation adoption process, has not been investigated in depth. In particular, limited exploration of the role of learning has been done using learning frameworks. As such, of the areas yet to explore, aside from a limited connection between levels of BRT and the learning achievement, there has not been an explicit study connecting the adopter category to the stages of BRT. Thus, what is potentially novel is how the cognitive theory embedded in Bloom's revised taxonomy interfaces with the different traits of the adoption categories from IDT. This is the research objective of this dissertation and the fundamental purpose of this study. This potential relationship, the role of learning in the adoption of an innovation, is important because it has implications to the design and delivery of various forms of instruction and communication in the adoption process. It also influences how these principles could be used to enhance not only a systemic diffusion of innovation, but also to accelerate the learning for each adopter cohort.

In summary, IDT is a leading theory widely used to understand, describe and measure the adoption of an innovation. In reviewing learning taxonomies BT is an influential and seminal work that shaped both theory and practice in education and training. While BT contained flaws opening the door for other classification schema, its use and application maintains its influence. The revision of BT, called BRT, addressed a number of the challenges within BT. BRT's current use, and rigorous review, establishes it as a leading taxonomy today. However, despite the prevalence of both core theories - other than limited connections - little research has been done connecting the two fields of learning and innovation in this manner via these two classifications and is the research opportunity at hand. In the next chapter we propose a research study to explore the relationship between IDT and BRT based on a theoretical model. In the fourth chapter the methodology that was employed to study this connection is discussed. Following this are two chapters on the findings and their discussion. Overall, this study addresses, in part, the numerous calls for more research by Cheney et al. (1986), Palvia (2000), Karuppan & Karuppan (2008), Straub (2009), and Rogers (2003) to investigate the connection between learning and the adoption of innovations.

Chapter Three - Research Objective and Model Development

Introduction, Problem Statement and Research Questions

Since members of an organization are likely to adopt and use a new technology in different ways, this variability has implications to the design of various forms of instruction and learning design. Design principles could be used to enhance a systemic diffusion of innovation and accelerate the successful adoption and usage effectiveness for each learner. In order to investigate the linkages and intersection between these elements, this study looked at the key components of learning taxonomies, and their connection points to IDT and technology, or adoption of innovations. While many models exist to explain how and why innovations are adopted, IDT, as a model, is the standard for defining and classifying innovation adopter groups and was the selected innovation adoption model.

Selection of a learning taxonomy for this study

In choosing a supplemental framework to explore the learning and educational connections to IDT there are several learning theories identified at the start of this section of the literature review that are available. Frameworks guide theoretical construction (Lithner, 2008, p.274) and can assist in the exploration of learning within IDT. Upon their examination of the literature Neumann and Koper (2010) put BRT in the top six classifications / taxonomies based upon their classification described in the section containing the introduction to learning taxonomies in chapter 2 earlier. Today many practitioners use BRT, mistakenly thinking it is the original and call it BT, revealed by an April 2015 web search for images about Bloom's taxonomy (http://www.bing.com/images/search?q=Bloom's+taxonomy&qpvt=Bloom%27s+taxonomy&FORM=IGRE). This web search shows numerous diagrams matching Bloom's revised taxonomy but labelled those diagrams as Bloom's taxonomy).

Anderson and Krathwohl (2001) do give some guidelines to leverage BRT effectively despite the challenges articulated earlier. They recommend four components that are important: 1) to spend time examining the "noun-verb" relationship, 2) to relate "knowledge to process", 3) to identify the "right noun phrase" and 4) to "rely on multiple resources" (Anderson & Krathwohl, 2001, p. 107). Furthermore, they note it is important to remember that what could be identified as a complex cognitive process in a lower grade level, can be a simpler process in higher grades (Anderson & Krathwohl, 2001). Prior learning does change where an objective could be classified in the taxonomy and plays a role (Anderson & Krathwohl, 2001, Denton et al., 1980). It is also important, according to Anderson et al. (2001), to remember the linkages between activities and means, objectives and ends, as well as assessment, and that assessment can become a de-facto objective. They also observed that certain grade levels or topics might heavily weight certain intersections in their rows and columns of the taxonomy table as represented in Table 3.1. For example, a grade 2 student in a language arts class may spend more time in the cells labelled A and a grade 11 student in an advanced English class may spend more time in cells labelled B. However, Zohar and Dori (2003) challenged the wisdom of such a distribution.

Table 3.1 *BRT Taxonomy Table (adapted from Anderson & Krathwohl, 2001)*

Dimension	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
Factual Knowledge	A	A				
Conceptual Knowledge	A	A				
Procedural Knowledge				B	B	B
Metacognitive Knowledge				B	B	B

The prevalence of use, the acceptance of the changes from the original, and most importantly, the splitting of the knowledge and cognitive dimensions make BRT an appropriate theory to apply in the study of learning and adoption of innovations. The connections between the knowledge transfer process contained in IDT link very well to BRT. While there are a number of revisions to BT, or other alternate schema, an important value of BRT is not in being content field specific (Anderson & Krathwohl, 2001). Furthermore, its nature as a general revision adds to its value in exploring IDT /BRT connections.

BRT is widely regarded and understood, and was used as the theoretical underpinning to apply against the stages in the adoption curve and cohort characteristics in how, and to what degree they use, a new innovation. Ultimately, Krathwohl (2002) suggests that BRT's taxonomy table (Table 3.1) allows a visual representation of objectives and assessments. Based on the overall advantages of BRT discussed above, this research used BRT as its learning taxonomy.

Research question

While the scope of BRT and educational taxonomy frameworks are far reaching, the review of the interface with IDT is limited to a finite set of intersection points. As identified in the literature review, aside from a limited connection between levels of understanding and the learning aspect of IDT, there has not been an explicit study connecting adopter categories to the stages of BRT. This is theoretically important because it provides a context for the knowledge factors in the innovation process not previously researched. Furthermore, from the literature review this has important significance and therefore is the research objective of this dissertation. Specifically, the research question for this study is

What is the relationship between comprehension levels according to Bloom's Revised Taxonomy among different (information) technology adopter cohorts?

While one could also examine the three learning domains of cognitive, affective, and psychomotor sets, we could also examine the overlaps between them that exist (see Figure 3.1). This research limits itself to the cognitive area for two core reasons. First, this study is looking at the role of learning in the adoption of a new innovation as opposed to the elements of emotion (affective domain) and physical skill (psychomotor domain). Second, BRT is specific to the cognitive domain. However, some consideration of the overlap between cognitive and psychomotor – labelled as overlap area 1 below – is important as it includes the element of physical actions in the cognitive learning process. Given the connection mentioned earlier between motivation and IDT, it is interesting to note that Keller's (2010) ARCS model also identifies motivation as overlapping between the cognitive and affective domains. The overlap of cognitive processes with affective elements (area 2) is not discounted in IDT, but the ability to effectively measure and monitor the role of the affective processes expands the scope and the complexity of the research beyond the scope of this dissertation. Overlap between the psychomotor and affective (area 3) is tertiary to the core role of cognitive components that is a fundamental aspect to this study. The center overlap area 4 is not being investigated for the same reasons as overlap area 2.

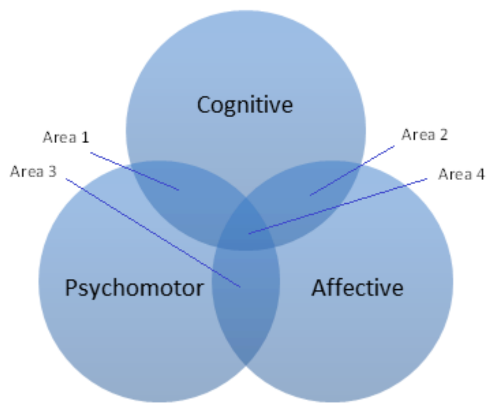

Figure 3.1 Overlap areas of Bloom's Taxonomy's three learning domains

Research sub-questions

In order to explore the relationship between IDT and BRT we need to first understand how to classify individuals into the IDT categories without relying on time as the key variable leading to sub-question SQ1. Time-based classification was not used because a method was desired that could be robust enough in the case that the population in question could not be considered to have been equally introduced to the innovation at the same time, or, if the population had not completed the full adoption cycle of the innovation. In short, an alternative method to a longitudinal study was needed to know which innovation adoption group the adopter belongs to.

SQ 1 With respect to a specific software innovation what indicators classify the degree of innovativeness by a person adopting a new technology according to the criteria of innovator, early adopter, early majority, late majority and laggard[1]?

Once we can classify an individual according to their innovativeness we then need to be able to identify the indicators that will help us associate their activities into a BRT cognitive level leading to sub-question SQ 2. Essentially we are looking to identify the users' use level and usage activity of the software used in this study and the degree of cognitive activities according to BRT that the adopter exemplifies.

SQ 2 With respect to a specific software innovation what indicators demonstrate the degree of comprehension and usage of a new innovation once it is adopted?

Finally, once we can identify the factors placing individuals and their level of cognition into the two theories we can examine the relationships between the common cohorts and leads us to sub-question SQ 3.

SQ 3 With respect to a specific software innovation how do the different cohorts in IDT adopter categories exhibit degrees of usage as characterized by BRT?

These questions lead into the use of a survey instrument explained in detail in Chapter 4 and that can be found in Appendix B3. Research question SQ 3 is the fundamental component of the over-arching research question and it will be tested by the examination of the proposition as described by the research model discussed next.

[1] Laggard is the term used by many Innovation Diffusion Theory models and has been recognized that it sounds like a bad name especially when non-laggards have a pro-innovation bias (Rogers, 2003). In actual interviews a synonym will be used to soften potential negative connotations.

Research Model

This study explores the interface of the adopter categories within IDT and the cognitive categories in BRT. The research practice to interface multiple theories and disciplines relating to a complex learning topic is not novel in, and of, itself. Gersick (1991) reviewed a selective exploration of the interrelationships between individual adult development, group development and organizational evolution. Using paradigm-shared constraints, Gersick (1991) related the principle of learning curve to complex systems and changes, such as innovation. This is one component on which the research question to connect the adoption of an innovation to learning taxonomies exists. Figure 3.2 conceptualizes a general map between the previously discussed elements of those two frameworks. Following the approach of Zohar and Dori (2003) the six categories have been consolidated into three groups in general, high, mid and low.

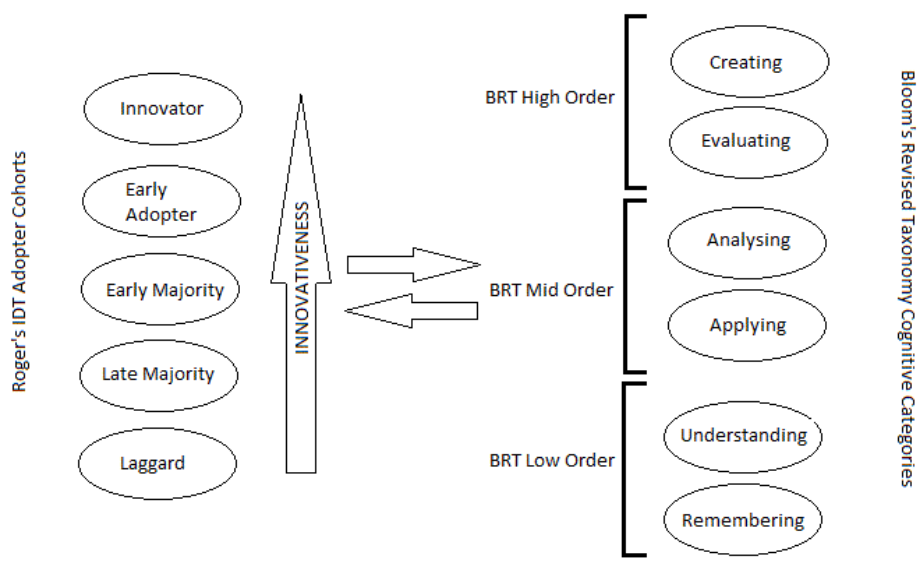

Figure 3.2 Exploring how Rogers' (2003) IDT categories interface with BRT categories

Zohar and Dori (2003) found that those with higher academic achievements demonstrated higher thinking skills than those with lower achievements. They also identified that higher order thinking is involved with scientific knowledge and technological innovation (Zohar and Dori, 2003, p149). This poses the possibility that higher innovativeness also could be connected with higher order activities. In particular, findings from Karuppan and Karuppan (2008), Zohar and Dori (2003) as well as the researchers experience in technology training have supported this premise. Notwithstanding that individuals can show evidence of cognition at multiple levels in BRT each category of the two frameworks is shown as a separate entity and the two arrows indicate the relationship between the frameworks as described in general in the literature review. It is represented as bi-directional as we do not have evidence to indicate causality in one direction or the other.

Additionally, from the literature review regarding IDT and learning curves, there is a proposition that can be developed. As a general guideline evolving from BRT, learners move from lower order to higher order activities over time. Thus, a learning 'comprehension' curve could be conceptualized to describe the stages of increased BRT cognitive complexity where, as a learner moves through each stage over time, we could examine the adoption process at an individual level as shown in Figure 3.3.

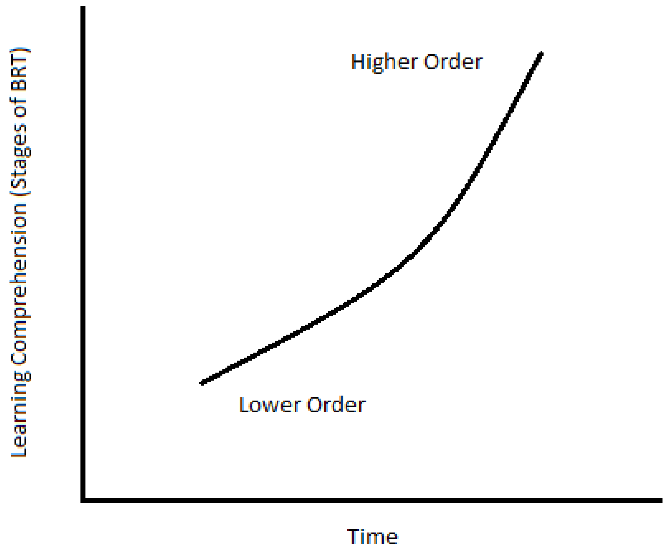

Figure 3.3 Moving upwards through the stages of BRT over time

Furthermore, as early adopters are more likely to be better educated (Rogers, 2003), and with education more higher order skills are developed, then there exists a potential relationship that early adopters exhibit a greater chance of operating at higher levels in BRT as depicted in Figure 3.4 and a greater frequency of activity at the different levels in BRT as depicted in Figure 3.5. Therefore, one can formulate the following proposition.

Proposition: The higher the degree of innovativeness the more likely an individual is to demonstrate greater frequency of activities at the higher order cognitive levels of Bloom's taxonomy

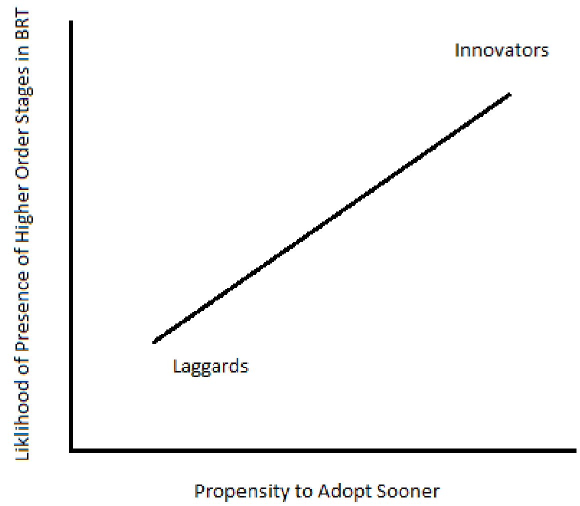

Figure 3.4 Presence of Activity at Higher Order Stages of BRT by Propensity to Adopt

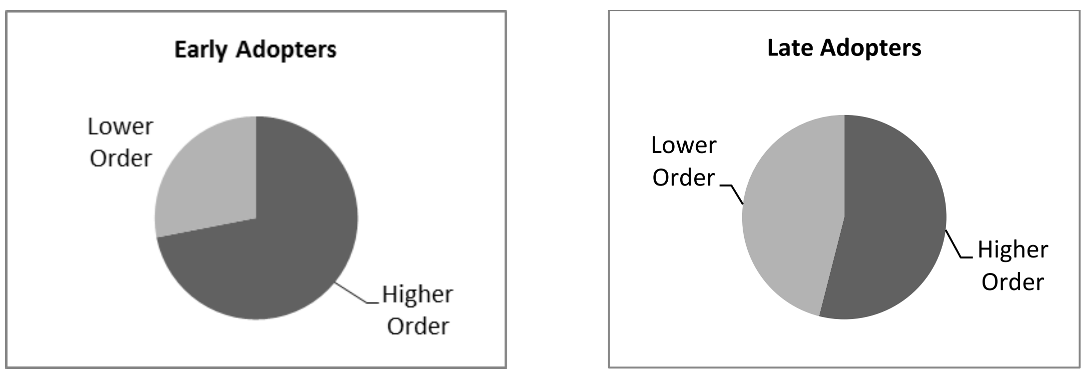

Figure 3.5 Proportion of activities at stages of BRT by adoption grouping

If the null hypothesis for the proposition is rejected this has an implication for how an organization planning to adopt an innovation can support different adopter groups within their organization and for which levels of functionality different users can be expected to adopt during the innovation adoption process.

Chapter Four - Methodology

This chapter highlights information gathered as part of the literature and specifically reviews methodological insights from studies on IDT and BRT. It then discusses the methodology to be employed for the study. Next, it describes the process of instrument creation, refinement and validation, the methods of data collection and analysis, and then wraps up with a summary.

Methodology Review

Searches on ABI-Inform, and Business Source Complete through the Athabasca University online library (http://library.athabascau.ca/journals/title.php?subjectID=2) were undertaken over a period of over two years (December 2012 through April 2015). The purpose was to review studies and literature on technology adoption, learning taxonomies, and software adoption. Additionally, searches through Google Scholar were performed and searches on articles citing seminal articles and then additional cited articles from those were investigated. A variety of Boolean logic strings were applied to sift through the search results. A specific emphasis to look for sample studies and theoretical frameworks connecting these theories occurred. The priority of the methodology review was to get a foundational background on which to base this dissertation and to guide methodological decisions. It was also to review trends, methodologies, issues, bias to avoid and question types used elsewhere.

Furthermore, part of the review was to identify existing valid questions related to IDT category classification. Since time does not serve well as the only method of classification into adopter categories questions from other instruments were sought out that would serve this purpose better. Additionally, questions that exist from studies to assess BRT classification were also sought out. Studies of Birman (2005), Lippert and Ojumu (2008), Foasberg (2011), Halawi, Pires, McCarthy (2009) and Mahajan et al. (1990) were used. This development process follows the recommendation from Boudreau, Gefen & Straub (2001) regarding item development. The instrument questions also incorporated the guidance from Anderson and Krathwohl (2001) listed in the section on challenges with BRT contained in the literature review to be as effective as possible.

This next section looks at a number of studies that reviewed aspects of IDT research, which have links to the proposed research question for this study. Later it then looks at aspects of BRT research from previous studies. The intent of the methodological review was to identify approaches and findings that can aid, or caution, approaches employed for this study. It then highlights specific areas of consideration and how they were incorporated into this study.

Methodological insights to IDT research from the literature

A recommended methodology by Rogers (2003) was to gather data at different points in time as a longitudinal study and not just studying the historical view of the adoption of an innovation. However, it is simpler to begin with a historical review than to perform a longitudinal study, unless one has the advantage of a fast adopting innovation that is identified at the right time in their review process. With the advent of many Internet-based innovations and the speed of knowledge transmission, this may be more feasible than it was over the past six decades of innovation diffusion research. A number of studies were investigated to identify methodologies used in related research. A number of search conditions in ABInform and Business Source Complete were conducted looking for articles, dissertations, and studies containing terms of innovation and learning. In particular, a more focused search criteria to source these articles included researching the studies of the adoption of 'windows' software or 'web browser' software as software is one common avenue to explore how learning interfaces with adoption of an innovation. Key methodological findings are included in Table 4.1 below.

Table 4.1 *Summary of closely related IDT research studies investigated*

Topic / Nature of Research and population	**Methodology and sample**	**Approach and findings**	**Comments and context**	**Author(s)**
Consumer durables adoption curve	Quantitative. Random sample of five hundred households. Total of 111 responses.	Classification into Rogers' categories was adoption time based. Mathematical model of group placement used.	Identified four factors in the decision to adopt or not.	Martinez and Polo (1996)
Mental model resilience in their study of over 300 super-users in an enterprise adoption	Quantitative. Regression analysis of 243 super-users performance scores in the organizations data system.	They identified three key factors that influenced adoption timing (near-transfer tasks, far-transfer tasks	Their regression model identified prior experience, time since training and	Karuppan and Karuppan (2008)

		and time to take the test). They also examined prior experience with windows based systems. One measure of competence employed was the number of calls to the help desk over two months.	far-task transfer as factors significant to a .001 level.	
Systemic study between four RM software options	Quantitative ratings of features using a rubric	Comparison of features and function. Psychometric data not provided.		Gilmour and Cobus-Kuo (2011)
Use of e-readers at a PSE setting	Quantitative survey with a sample size of 401 users from 1705 respondents.	Compared student usage to adoption factors from literature	Limited the number of questions for non-users of the innovation, compared to users.	Foasberg (2011)
Examined the likelihood of adopting e-voting to the degree of innovativeness of residents of New jersey, Pennsylvania and Georgia, USA	Quantitative self-reported questionnaire with a sample size of 165	Regression analysis. Many of their questions used to classify respondents into the adoption categories were newly developed and then validated in their study. Cronbach alpha values for	A number, but not all, of these questions were used for this study as part of the exploratory principal component analysis (see Appendix B2).	Lippert and Ojumu (2008)

		constructs ranged from .751 to .810.		
Employees in a company on the use of windows software. Pilot tests sent to 300 individuals. Final surveys sent to all 977 PC users in the organization.	Quantitative survey questionnaires. Final sample size included a total of 230 respondents.	Their methodology was very robust with pre-test, pilot test, factor analysis, and regression. Cronbach alpha on constructs ranged from .71 to .98 except for one construct at .50	The focus of this study was to consider relationships on the intent to adopt and then usage after adoption.	Karahanna, Straub and Chervany (1999)
Social learning process for new users in 'Second Life'	Exploratory qualitative study of ten subjects	By introducing a cohort of users with no previous experience to 'Second Life' Morse (2010), researched the experiential learning to observe the diffusion process and then collected data through various forms of feedback such as interviews.	Specifically considered the "application" stage of BT in an adoption of an innovation	Morse (2010)

Through the research into these studies and during the literature review there are a number of issues that surfaced and that should be avoided or addressed:

- Testing and validating the instrument is extremely important and two key articles (Straub, 1989; Boudreau et al., 2001) in MIS Quarterly addressed this important facet.
- Difficulties with the size of the innovator adopter group (usually two percent of the population or less) of the sample based on a normal distribution make this group quite small relative to the rest of the population. As a result, some studies (Mahajan et al., 1990) combine innovators and adopters.
- The Karuppan and Karuppan (2008) study utilized some multiplication of variables before the regression analysis. This may have impacted the study with issues of multi-collinearity. Therefore a formal examination of collinearity is required for all variables, as well as any composite variables.
- Many studies have used time or mathematical calculations (Bass, 1969; Mahajan et al., 1990; Rogers, 1962) to determine adopter categories and then identified the characteristics of members in these categories. This study used the characteristics that have been identified by research to place adopters into categories and then compare the assigned categories with the nature of their usage according to BT traits of the new innovation.

Methodological insights to learning taxonomies research from the literature

BT, BRT, and other learning taxonomies are not a new field. Therefore, they have been discussed, researched, and examined a number of times and it is instructional for us to leverage the methodological approaches of the previous studies and the strengths / weaknesses of the research methods that they used. A number of studies were examined for methodological approaches regarding BT, BRT, or other learning classifications. A number of search conditions in ABInform and Education Source Complete through the Athabasca University Library online portal (http://library.athabascau.ca/) were conducted looking for articles, dissertations, and studies containing terms of innovation and learning. In particular, a more focused search criteria to source these articles including studies of the adoption of technology in education, Bloom's taxonomy and adopting innovations, Bloom's revised taxonomy and adopting innovations. A number of variations of those search terms were used to widen the possibilities of identifying related topics. A summary table of the findings follows in Table 4.2 below.

Table 4.2 *Summary of various current and seminal learning taxonomy and BRT related research studies investigated*

Topic / Nature of Research and population	Methodology and sample	Approach and findings	Comments and context	Author(s)
Impact of laptops on student learning to achieve different levels in BT	Quantitative survey	17 question, 4 choice Likert style with no middle value questionnaire to faculty and students	Instrument explored all three learning domains. Article did not provide psychometric data.	Odhabi (2007)
Instructional method and classifications review	Quantitative meta-analysis	Cluster analysis on 37 different classification schema followed by discriminant analysis, they included a very	They found that most authors seldom used empirical approaches to create	Neumann and Koper (2010)

		detailed methodology for their quantitative methods. Pearson correlations significant to .01 for 29 of 30 scales, 30th was significant to .05	classifications, they demonstrated how you could do so. Cross-validation yielded between 79% and 100% certainty for their classifications.	
Memorization methodology and efficiencies	Quantitative	Quantitative study regarding memorization and recall	Seminal study regarding learning curves explored a lower stage of BT.	Ebbinghaus (1885)
Learning curves of 2279 Dutch firms that had innovative products in a six year window	Quantitative survey data	They used descriptive statistical techniques, performed a rudimentary regression (R^2 of .50). Used screening questions to determine which firms would be involved in the study.	Explored specific details of the learning curve by using secondary data from the Dutch section of the Community Innovation Survey.	Brouwer and Van Montfort (2008)
M-Learning adoption	Qualitative integrative literature review	Various case examples with limited rigor	General connection between BT and IDT	Crescente and Lee (2011)
Thinking skills and 7th to 10th grade science	Qualitative to a total sample size of 978 students	Four case studies of learning modules, questions asked	Low-achieving students benefited from instructional	Zohar and Dori (2003)

students in Israel		and then rated according to a complexity scale regarding the level of cognitive process, quantitative assessment between high and low groups in each case study. Used a variety of critical thinking tests to measure complexity. Kruskal-Wallis test to better than .001 significance.	styles that encouraged higher-order thinking as well as the high achieving students.	
Use of the SOLO taxonomy and accounting	Qualitative case study of 57 accounting students	Two cohort case study of accounting classes at universities asked to "explain" a concept. Rudimentary descriptive statistics as a quantitative analysis was done on each of the five categories	They created a rubric to use to quantify that incorporated descriptors and context for each of the five SOLO classifications. They did not intend to create a definitive framework for the SOLO categories.	Lucas and Mladenovic (2009)
Classifications of three divergent lecture styles in a medical school	Quantitative survey to three lecturers, quantitative survey to 102 students and	Selective sample pre-lecture questionnaires to the lecturer which were content analyzed,	Methodology of classification is far more limited than BRT and is limited to the	Saroyan and Snell (1997)

	Qualitative analysis of lecture videotapes	observations of lectures through videotapes of the lecture coded using syntactical markers and content and topical analysis, student rating of lecture using a ten question, five-point Likert scale with ANOVA and Tukey HSD analysis	context of lectures

Through the research into these studies and during the literature review there are a number of issues that surfaced and that should be highlighted:

- The initial screening approach from Brouwer et al. (2008) methodology is strong and is consistent in this study, but the analysis also expands beyond the descriptive focus of analysis by them.
- Using a method to develop a future scaled instrument follows a methodology done by Benamati and Lederer (2001) to clarify concepts, develop indicators, and evaluate indicators.

Methodology Employed

The general explorative methodology employed is a quantitative field study approach (Boudreau et al., 2001) designed to assign categorization to Rogers' classification in IDT and assess the nature of learning through measurements related to BRT. General demographic data was collected to identify characteristics of the sample that might confound results, cause bias, or identify other relationships. Thus, the dissertation study proceeded with two major steps. First, the research utilized measurement indicators intended to demonstrate a) the propensity to adopt a new technology according to Rogers' Innovation Diffusion Theory (IDT), and b) the sophistication of technology use once adopted according to Bloom's Revised Taxonomy (BRT). The second, and deeper, research problem that is being addressed is to relate competency of use with stage of adoption of the technology innovation.

The adoption of reference management (RM) software such as RefWorks or Mendeley (Gilmour & Cobus-Kuo, 2011) was chosen as the context for investigating the research question. The selection of reference management software was chosen because it generally does not fall under authority-driven adoption - the target population has previous and alternative methods to accomplish the task that reference management software is designed to accomplish and the audience is relatively easy to identify. There are relatively low barriers to access for the chosen technology for the demographic group in terms of cost or equipment mitigating the influence of those components of the adoption factors. Both existing long term users of RM software and new users of RM software are members of the targeted population. Uses could be as simple as bibliography creation to full research activities as part of thesis and dissertation development (Gilmour & Cobus-Kuo, 2011) – see Appendix B1 for features list.

After the conclusion of the quantitative phase a small number of semi-structured interviews were done with the target population to provide some rich, real-world data. In order to perform a results confirmation, the approach of an interview analysis consistent with Karahanna et al. (1999) was conducted to perform a high level validation of the results by interviewing a total of twelve faculty and graduate level students. While not an intensive or rigorous mixed method approach the qualitative phase builds on the quantitative phase that adds depth and enhances the study (Creswell & Plano, 2011). Furthermore, the intent of the qualitative phase was to triangulate the quantitative results in the context of rich, real world and personal data as is often employed in social science research (Creswell & Plano, 2011). As described by Creswell & Plano (2011) a mixed methods approach can help explain quantitative findings or generalize results of exploratory findings.

Instrument development and pilot study

The initial version of the online quantitative instrument (see Appendix B2) with its informed consent was developed from the exploratory research and literature review detailed above. The informed consent was developed by refining samples from Foasberg (2011) and Birman (2005). Ethics approval (Appendix E) was obtained in advance of conducting the pilot study. The initial version of the instrument used applicable questions from the studies identified in the summaries listed in tables 4.1 and 4.2 as a starting point. A number of questions were modified to fit the context of this study. Constructs that needed items not found in other studies had new questions modeled after those existing in other studies and were further developed to explore the construct in question. The first step undertaken was to test the initial version of the instrument on a small group (non-probability, convenience sample) to identify reliability, validity or mechanical issues with the instrument. This follows the practice recommended by Straub (1989), Boudreau, et al. (2001) and Premkumar, Ramamurthy and Nilakanta (1994) to enhance content and construct validity. The pilot study group included some who were experienced in instrument development and some that were content experts to provide a balanced review and enrich feedback robustness. The pilot study instrument also included four additional open-ended questions listed below (the first three being original while the last one being adapted) that were used to refine the instrument and, consequently, were not included in the final questionnaire:

1) How did you feel about the survey length?
2) Which questions did you find it difficult or impossible to answer? Why?
3) Did you feel the set of questions on RM usage were appropriate?
4) Do you have any survey layout or wording improvement recommendations? (Dwivedi, Choudrie & Brinkman, 2006)

Pilot study logistics

The pilot study group were members of the Athabasca University (AU) Doctorate of Business Administration (DBA) cohort(s) and professors with the AU DBA program excluding the researcher, members of the researcher's supervising committee and colleagues of the researcher at the University of Victoria (www.uvic.ca). Pilot study participants at Athabasca University were recruited through an invitation email that was distributed by the DBA Program Director on behalf of the researcher. University of Victoria professors were recruited by an invitation email from the researcher. Participation was anonymous and voluntary as the email invitation contained a link to the survey and no personally identifiable data or tracking of respondents occurred. The pilot study occurred during the period of June 27 through August 2, 2014 with one reminder invitation approximately two thirds of the way through the collection time period. Approximately 30% of the total responses were gained after the reminder; however, nearly 90% of the responses occurred within 3 days of either the initial invitation or the reminder. Table 4.3 below shows the response rate demographics for the pilot study.

Table 4.3 *Pilot Study Response Rates*

Category	Faculty	Students
Invited	60	48
Participated	15	14
Response rate	25%	29%

Note: Some respondents were both students and faculty

An analysis of the pilot study data was performed using the processes recommended for the full study (as identified in the section in chapter 4 on Data Manipulation, Controls and Analysis). Overall, sufficient confidence in the results of the pilot study with respect to reliability and construct validity (see chapter 5) identified that, subject to the modifications described in below, the overall methodology would be appropriate for use in the main study.

Adjustments to the instrument based on the pilot study findings

Following the submission responses of all participants included in the pilot study the results of the quantitative analysis from the pilot study and the extra qualitative questions from the same study, redundant and non-value adding questions were dropped from the final instrument. Questions that generated the need for reverse coding were reviewed and reworded where appropriate. The five-point Likert scale used in the pilot was revised to a seven-point scale to achieve better variability of the answers and, consequently, pilot study results were not included in the final study analysis. Frequency scales were also refined to a seven-point scale. Also, important questions with deficiencies, such as reliability, were refined. Some question wording was further refined for better flow and consistency (see Appendix B3.1 for a summary of changes). The instrument included both screening questions and flow logic for branching based on screening questions. The survey instrument being used was also tested multiple times for branching logic and deployment ability to different web browsers. As a result, the quantitative survey instrument was refined and the updated mapping of questions to constructs is found in Appendix B3.2. Note that in addition to common demographic questions such as age, occupation status or years of computer use, some additional demographic questions were asked about publication frequency and computer experience in an academic setting as these were perceived that they could have some bearing on the likelihood of adopting RM software. The final survey instrument is presented in Appendix B3.3. This was then submitted for a revised ethics review and subsequently approved.

Data Collection

The population that this sample was drawn from has two main sub-groups – Canadian graduate students and Canadian academic faculty or researchers. At the beginning of the second decade of the 21st century, according to the 2011 Canadian NOC data, there have been approximately 40,000 faculty (http://www5.hrsdc.gc.ca/NOC/English/NOC/2011/Welcome.aspx). Association of Universities and Colleges of Canada (AUCC – www.aucc.ca) also reports about 42,000 full time faculty professors in Canada (http://www.aucc.ca/canadian-universities/facts-and-stats/) as of April 2015. According to Elgar (2001), there were 100,000 graduate students in Canada at that time. Statistics Canada reports that number to be over 165,000 as of 2008 (http://www.statcan.gc.ca/pub/81-599-x/81-599-x2009003-eng.htm).

Using institutional websites identified from the AUCC website, seventy-three members institutions (as of December 2014) e-mail addresses were obtained for the four sub-groups below. Not every institution had an available e-mail for each sub-group 1 through 4 below. Appendix B4 lists the number of functioning e-mails sourced and the time period that they were sent the invitation to participate from the 73 possible. The e-mail invitations asked for assistance in distributing the study invitations to members of their respective sub-groups below

a. Subgroup 1: the Faculty Associations at universities and colleges (59 e-mails),
b. Subgroup 2: the Graduate Student associations, or similar (50 e-mails) of each institution,
c. Subgroup 3: the university librarians and assistant librarians of each institution (59 e-mails),
d. Subgroup 4: the Dean's administrative assistant for the Faculty of Graduate Studies (or equivalent) at each institution (37 e-mails) with a request that they obtain permission from the Dean to forward on to full, associate, assistant, and adjunct professors, lecturers and students in their faculty.

In addition to the four sub-groups listed above, forty Canadian universities were drawn randomly from the Association of Universities and Colleges of Canada (AUCC – www.aucc.ca) membership. In total 1290 Program Directors or Coordinators (or equivalent, such as Program Assistant) of the graduate degree programs within those forty institutions were requested to forward the e-mail invitation to their current registered graduate students and faculty. When an institution had policies, or other constraining factors, which prevented or severely limited the ability to sample, it was replaced by another randomly selected institution. There were a total of fifteen replacements. See Appendix B5 for full details on the each wave and the time period of the successive waves of data collection.

For the desired level of robustness, a total sample size larger than 300 complete responses was targeted. When conducting a Principal Components Analysis (PCA) a sample size of 300 cases is considered good and the subject to item ratio used in a PCA is recommended to be greater than 5:1, preferably greater than 10:1 (Field, 2005; Nunnally, 1978, p. 421; Gorusch, 1983; Hatcher, 1994; Aleamoni, 1976; Osborne & Costello, 2004; Comfrey & Lee, 1992) (see also Appendix B4). In total, just fewer than 1,500 e-mail invitations were sent out as per the process above. From the email requests to the groups above, and their subsequent communication to their networks, 462 responses resulted, of which 398 completed the survey to the final page and were used in the full analysis. Forty-seven responses were incomplete to the extent that respondents exited the survey on page one or did not even complete the technology question set. Seventeen responses were partially complete to include at least all the questions on the technology domain but respondents exited the survey early and did not complete the majority of the survey. None of those were used in the analysis.

At the conclusion of the quantitative instrument respondents were provided a contact email that they could express interest in participating in the follow-up qualitative phone or email interviews. There were a total of 19 individuals that expressed a willingness to participate in the follow-up interview. Each of the 19 individuals were then sent an email that asked if they preferred phone or email format and provided a consent form. Of those, 15 responded with a completed formal consent during the data collection period. They were also asked for a preferred time for the interview and provided a copy of the semi-structured interview questions (found in Appendix B3.4). Of those 15, twelve fully completed the interview phase. During the interview some follow-up questions for clarity were asked as needed to understand the responses better.

Data Manipulation, Analysis and Controls

Lippert & Ojumu (2008) state that gender can impact affinity towards technology and therefore there is the need to control for gender. Other controls were for education and age of the respondents. Fully incomplete cases were deleted and partially incomplete data and missing variables within cases were handled preferentially by pair-wise deletion (i.e., only removing the case if one of the two variables in the specific correlation being examined is missing) in order to retain the data generated by non-adopters of RM software for general questions and list-wise (i.e., removal of the complete case from the analysis when any data being analyzed is missing) when pair-wise approach was not appropriate (such as the analysis of correlation between adoption classification and BRT activity levels). Comparison analysis was done on data to ensure there was no bias on the general questions due to pair-wise deletion methods (Appendix D1). At this stage the quantitative data were checked and cleaned for consistency. Likert variables were recoded into an ordinal scale by converting Strongly Disagree, Disagree, Somewhat Disagree, Neither Agree or Disagree, Somewhat Agree, Agree, Strongly Agree to the values 1 through 7 respectively. Frequency variables were recoded into an ordinal scale by converting Never, Almost Never, Infrequently, Sometimes, Often, Almost Always and Always to the values 1 through 7 respectively. A few of the Likert and

Frequency survey questions required reverse coding in the analysis to properly reflect the construct. Three demographic variables, (gender, student or non-student, faculty or non-faculty) were recoded as dummy variables for analysis purposes. SPSS software (http://www-01.ibm.com/software/analytics/spss/) was used as the statistical package to perform theses analyses.

Specific analysis techniques were applied in a precise sequence. First, a series of tests to verify the accuracy of measurement model were performed:

1. Descriptive statistical analysis which included mean, median, mode, range and variance calculation. There was a frequency analysis as well.
2. Exploratory principal components analysis (PCA) tested construct validity (Straub, 1989; Boudreau et al., 2001; Premkumar et al., 1994). A varimax rotation with a loading coefficient of 0.50 was applied (Dwivedi et al., 2006; Halawi et al., 2009; Lippert & Ojumu, 2008) to ensure only appropriate loaded items contribute to the respective composite metrics.
3. Cronbach's alpha (Cronbach, 1951) was employed for construct reliability analysis for both dependent and independent constructs with a desired threshold of at least 0.70 (Nunnally, 1978). The resulting loaded factors were also tested to identify any items that, if removed, increase reliability.
4. As part of the analysis, a check for multi-collinearity was performed with collinearity diagnostics. Additionally, the PCA was tested for its appropriateness using standard measures of a KMO measure for sampling adequacy (Kaiser, 1970) and a Bartlett test of sphericity

(Bartlett, 1950) to confirm that the PCA is not being performed on an identity correlation matrix and is suitable for data reduction.

Next, two tests to assess the theoretical model were performed:

1. A bivariate correlation analysis was the detailed tool testing the research proposition. The purpose was to determine the measure of association using the correlation value and the p-values of significance similar to approaches used in studies such as Ash (1997), Kimberly (1978) and Agarwal & Prasad (1997) as well as following a methodological perspective provided by Boone & Boone (2012).
2. A cross-tabulation analysis was another tool for testing the proposition. Additional cross-tabulations were generated against the demographic data to identify their possible influence and significance as control variables. A Chi-Square test was used to ascertain significance, comparing the data generated from the factors loading to IDT classifications against the data generated from the loading of factors for BRT. The variables being used in the cross-tab were recoded into bins with expected values of 5 or greater in order to meet commonly accepted requirements on using Chi-Square analysis (Hair, Black, Babin, Anderson & Tatham, 2006; Cooper & Schindler, 2011).

Following the PCA analysis one of the manipulations that were performed on the data was to create a composite metric from the variables that loaded on the same factor (Agarwal & Prasad, 1997; Boone & Boone, 2012; Lippert & Ojumu, 2008). A mean value was generated for the composite that was an average of the Likert scales of the variables that loaded to that factor. Once the composite components were developed, the component related to innovativeness was used to classify each case by one of four adopter cohort classifications (early adopter, early majority, late majority and laggard). Innovators and early adopters were combined together into the first group for this category assignment due to the small size of those cohorts relative to the others.

The qualitative interview data was analyzed for themes and key words. First, the demographic status of faculty or student was obtained for each respondent. Then, based on the Rogers' (2003) descriptions of each adopter group the interview responses to questions 1a and 1b (see Appendix B3.4) were used to identify the adopter group the respondent most likely belonged to. Answers to questions 2a through 2c were then classified to common descriptors matching terms in the literature, and consistent with the terminology used in the quantitative study, either through direct word match or by synonyms. Finally, the descriptors were grouped into themes as shown later in the findings (Table 5.22).

Summary

The methodology described above was chosen for this dissertation based on some approaches to assess theoretical models quantitatively as identified in relevant literature. Overall, the methodology was used to concentrate the focus on the key aspects of innovation adoption as they relate to the role of learning in the adoption process. Also, it was intended to control as much as possible for the many other variables involved in the diffusion of innovations and still have a meaningful connection to the overall process.

Chapter Five - Findings

Outcomes of the Pilot Study

The data for the sample characteristics for the pilot are found in Appendix C1. In total there were 26 respondents. Nineteen of them were female and over half of the sample were between 46 and 55 years old. Key observations from the sample characteristics indicate that only approximately 50% of the participants identified themselves as regular users of RM software, yet the average experience among the 19 people who have used RM software was less than 4 years. Overall, the time spent on personal computing devices was high (23 of 26 respondents were using a device over 20 hours per week). Additionally, the participants have been using computers for a long duration (lowest value was over 20 years).

The principal component analysis (PCA) was performed on the pilot study data using SPSS statistical software and was used in part to classify the innovativeness of the sample population (see Appendix C2 with specific details for the total variance (Appendix C2.1), rotated factor solution (Appendix C2.2) and corresponding Cronbach's alpha values (Appendix C2.3)). Due to the small sample size, the principal component analysis suppressed coefficients smaller than 0.6 (Field, 2000; 2005). This also impacted the determinant of the PCA matrix that, due to the sample size, it was not positively definite. From the principal component analysis, two IDT constructs were generated and three BRT constructs were identified. The sixth component was generated from a single loaded item and was removed for the purposes of the pilot study analysis. All five of the remaining components had sufficiently high Cronbach's alpha values to warrant being retained for the pilot study analysis. None of the generated components would have been significantly more reliable by dropping items that were loaded. At this stage, composite measures were generated (aggregated) for the IDT and BRT constructs based on the loaded factors. These constructs were named based on a three-step process. Naming of the constructs generated was based upon theories from the literature review, then aligned with the ranking of feature complexity (Appendix C3), and finally cross-referenced with the descriptions used by respondents in the open-ended questions in the pilot study. This resulted in the means for the composite measures as shown in table 5.1 for the 19 complete pilot study cases.

Table 5.1 *Descriptive statistics for the composite values resulting from the PCA components*

Composite Measure	Mean	Std. Deviation
Innovativeness	3.61	.87
Tech Application	4.07	.61
BRT Low Order	3.63	1.06
BRT Mid Order	3.57	1.18
BRT High Order	2.84	.94

Due to the small sample size and low expected counts in cells, key cross-tabulation relationships were not performed for the pilot study (Appendix B4). The final statistical test on the pilot study was a correlation analysis between the resulting constructs. Table 5.2 reveals the data from the correlation analysis.

Table 5.2 *Correlation coefficients for IDT and BRT Components*

Component	Statistic	Innovativeness	Personal Technology Expectations	BRT Low Order	BRT Mid Order	BRT High Order
Innovativeness	Pearson Correlation	1	.535**	.385	.303	.462*
	Sig. (2-tailed)		.007	.104	.194	.035
	N	26	24	19	20	21
Personal Technology Expectations	Pearson Correlation	.535**	1	.404	.223	.392
	Sig. (2-tailed)	.007		.086	.345	.087
	N	24	24	19	20	20
BRT Low Order	Pearson Correlation	.385	.404	1	.560*	.420
	Sig. (2-tailed)	.104	.086		.013	.074
	N	19	19	19	19	19
BRT Mid Order	Pearson Correlation	.303	.223	.560*	1	.232
	Sig. (2-tailed)	.194	.345	.013		.326
	N	20	20	19	20	20
BRT High Order	Pearson Correlation	.462*	.392	.420	.232	1
	Sig. (2-tailed)	.035	.087	.074	.326	
	N	21	20	19	20	21

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Main Study Results

In total 462 respondents were recruited from the seventy-three AUCC member institutions according to the methodology described in chapter four. Of these, 398 cases were considered complete responses and used in the subsequent analysis.

There were a number of demographic elements captured in this study. Of these, the key ones are provided in the tables 5.3 to 5.11 below. Table 5.3 identifies the gender distribution of the sample as well as the employment classification of the respondents. Roughly, two-thirds of the respondents were female and three-quarters were graduate students.

Table 5.3 *Gender and occupation status*

Characteristic	Percent
Gender	67% female and 31% male with 2% unstated
Faculty versus Student	79% graduate student (split evenly between Masters and Doctorate), 18% faculty, 3% other

Table 5.4 provides an insight to the age distribution of the respondents. Nearly one-quarter were in the 18 to 25 year old demographic, another quarter in the 26-30 year age bracket and less than ten percent were 51 years or older.

Table 5.4 *Respondent Age Distribution*

Age Category	Frequency	Percent
Undisclosed	4	1
18-25	107	26.9
26-30	105	26.4
31-35	69	17.3
36-40	33	8.3
41-45	26	6.5
46-50	17	4.3
51-55	18	4.5
56-60	8	2.0
61-65	5	1.3
66 or older	6	1.5
Total	398	100.0

Approximately half of the respondents spent in excess of 40 hours per week using some form of computer or device. At the lower end of the distribution less than one quarter spent less than twenty hours per week using computers, as seen in Table 5.5

Table 5.5 *Number of Hours per week spent on a Computer or Device*

Weekly Hours on Computers	Frequency	Percent
Undisclosed	2	.5
1 to 10	9	2.3
11 to 20	18	4.5
21 to 30	65	16.3
31 to 40	104	26.1
41 or more	200	50.3
Total	398	100.0

The largest segment of the sample (about 45%) used three to five different types of software in an academic setting. The second largest segment (as seen in table 5.6) was slightly over twenty-five percent and used six to eight different types of academic software.

Table 5.6 *Number of Different Types of Software Used in Academic Setting*

Number of Different Types of Software Used	Frequency	Percent
Undisclosed	5	1.3
2 or less	19	4.8
3 to 5	175	44.0
6 to 8	106	26.6
9 or more	93	23.4
Total	398	100.0

Publication frequency was also established. Respondents were asked if they had published and then asked how many journal publications they have had in the last seven years. Roughly, half of the respondents had never published and of the half that had published less than one quarter had published four or more articles in the last seven years (see table 5.7)

Table 5.7 *Number of Articles Published in Last Seven Years*

Number of Articles	Frequency	Percent
Have not published	181	45.5
None	3	0.8
1 to 3	119	29.9
4 to 7	47	11.8
8 to 12	13	3.3
13 to 20	16	4.0
21 or more	12	3.0
Not Sure / Undisclosed	7	1.8
Total	398	100.0

However, respondents were also asked how many articles that they have currently underway. Table 5.8 shows that only eleven had no articles currently in progress. Two-thirds of the respondents had between one and three articles underway, split fairly evenly between one, two and three categories.

Table 5.8 *Number of Articles Currently Underway*

Number of Articles	Frequency
Undisclosed	20
0	11
1	82
2	84
3	85
4	50
5	29
6	13
7	7
8	2
9	1
10	8
12	1
15	3
20	1
80	1
Total	398

Respondents were asked if they used an RM tool and if so then what tool they have been using. About one-fifth said that they did not use a RM software tool and thirty-nine specified a different tool than the RM software options that were provided in the survey. Table 5.9 shows the distribution of tools identified.

Table 5.9 *Distribution of RM software tools used*

RM Software	Frequency	Percent
Don't use a tool	87	21.9
EndNote	86	21.6
Mendeley	70	17.6
Other (Specify)	39	9.8
RefWorks	56	14.1
Zotero	60	15.1
Total	398	100.0

Descriptive Statistics Analysis

A number of descriptive statistics analyses were performed and the results are captured in the following tables. The descriptive statistics on respondent computer experience and research productivity in table 5.10 do not include those respondents that did not answer to that specific question. Thus, there were three respondents that did not indicate the number of years of computer use, twenty that did not disclose how many articles they were currently working on and 83 that did not show their RM software experience. It is interesting to note that four people responded that they did not use an RM software and yet responded to the question regarding how many years they have used RM software. These answers were included in the 0 years category. At a mean of 4.60 years of RM software usage it indicates a relatively balanced audience between seasoned users and new users. See Appendix D1 for a comparison between all 398 cases and the 311 cases that indicated adoption of RM software.

Table 5.10 *Years using a computer, years using RM software, and number of research articles*

Characteristic	N	Minimum	Maximum	Mean	Std. Deviation
Computer use (years)	395	4	50	20.44	6.86
Number of current research articles	378	0	80	3.28	4.63
RM software use (years)	315	0	30	4.60	4.40

One of the main factors that descriptive analysis was used for was to review the complexity ranking of features as perceived by the respondents after the data were coded. Table 5.11 below identifies the results. Respondents that do not use RM software or that did not answer the complexity questions account for the difference in N values for the descriptive statistics in table 5.11.

Table 5.11 *Feature Complexity Ranking Descriptive Statistics*

Feature	N	Minimum	Maximum	Mean	Std. Deviation
Store & Track	289	1.00	6.00	4.59	1.56
Sort & Organize	289	1.00	6.00	4.15	1.43
Generate Bibliography.	285	1.00	6.00	3.95	1.52
Annotate	287	1.00	6.00	3.33	1.52
Share References	289	1.00	6.00	2.56	1.47
Integration	288	1.00	6.00	2.34	1.49

Principal Component Analysis and Reliability

The following Varimax rotated component solution occurred with the PCA analysis on the coded Likert scales (determinate significance of less than 0.001) with acceptable KMO and Bartlett results (also with a significance of less than 0.001). The cut-off threshold included components only if their respective Eigenvalues were greater than one (total variance data can be found in Appendix D2).

Table 5.12 *Rotated Component Matrix*

	Component					
Item	1	2	3	4	5	6
Try New Technologies		0.778				
Comfort with Jargon		0.791				
Give Advice		0.726				
High Expectations						0.562
What can the tech do for work						
Quality is Important					0.81	
Look to Others for recommend					0.545	
Availability of Support				0.728		
I can explain functions	0.687					
Navigate Proficiently in RM	0.687					
Use Annotations	0.557					
Create Folders	0.673					
Same RM with co-authors			0.788			
Tech Not Worth the Cost (reverse code)						0.651
Fear of High Tech (reverse code)		0.709				
Technology will Fail (reverse code)						0.597
Use RM to Keep Track	0.754					
Use RM to Generate List	0.635					
Use RM to Sort	0.815					
Share Refs using a RM			0.73			
Customize and Integrate			0.528			
Need Assistance in using RM				0.576		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Table 5.13 *KMO and Bartlett's Test*

Test	Statistic	Result
Kaiser-Meyer-Olkin	Measure of Sampling Adequacy	.734
Bartlett's Test of Sphericity	Approx. Chi-Square	854.627
	df	231
	Sig.	.000

Cronbach's alpha reliability tests were performed on the six components produced by the PCA with the first two components exceeding an alpha value of 0.8 (high reliability) and the third one at 0.608 (moderate reliability) (see table 5.14 below for the summary and appendices D3.1 through D3.6 for each individual reliability table). Components four, five and six are other aspects of innovation adoption group characteristics. However, these last three components were significantly below the reliability threshold as set by Nunnally (1978) or the scale range identified by Hinton, Brownlow, McMurray, and Cozens (2004) to warrant further consideration.

Table 5.14 *Summary of Component Reliability Results*

Component	Cronbach's Alpha values based on standardized items
Component 1 (BRT Low Order)	.859
Component 2 (Innovativeness)	.820
Component 3 (BRT High Order)	.608
Component 4 (Support Reliance)	.459
Component 5 (Product Quality and Reference Reliance)	.250
Component 6 (Personal Technology Expectations)	.514

The first three components that did pass the reliability test were then created into their relative composite metrics. The descriptive statistics of those composite metrics are shown in table 5.15.

Table 5.15 *Descriptive Statistics for Composite Measures*

Composite Measure	Mean	Std. Deviation
BRT Low Order	5.15	1.23
Innovativeness	5.17	1.24
BRT High Order	3.71	1.47

Bivariate Correlation Analysis

A number of correlation analyses were performed. The most significant correlations examined were between the composite metrics that were generated from the PCA results. Table 5.16 shows the results of these correlations using pairwise deletion for missing data. Overall, the results show that innovativeness is correlated to both BRT Low Order and BRT High Order, and that BRT Low Order and BRT High Order are correlated to each other.

Table 5.16 *Correlations for Composite Metrics*

Component	Statistic	Innovativeness	BRT Low Order	BRT High Order
Innovativeness	Pearson Correlation	1	.290**	.229**
	Sig. (2-tailed)		.000	.001
BRT Low Order	Pearson Correlation		1	.424**
	Sig. (2-tailed)			.000
BRT High Order	Pearson Correlation			1
	Sig. (2-tailed)			

**. Correlation is significant at the 0.01 level (2-tailed).

Additionally, three other correlations were analyzed for confirmation and exploratory purposes. One of these was examining the correlation of the composite "innovativeness" metric against the frequency of use for the six main features of RM software (see table 5.17). While the correlations are statistically significant they have low correlation coefficients.

Table 5.17 *Correlation of Innovativeness versus frequency of feature usage*

Feature	Correlation to Innovativeness (using Kendall's tau B)	Significance
Use RM to Keep Track	.206	< .001
Use RM to Generate List	.114	.009
Use RM to Sort	.098	.023
Share References using a RM	.146	.001
Customize and Integrate	.225	< .001
Use Annotations	.102	.018

Second, the relationship between innovativeness and the number of types of software used in an academic setting was investigated and found to have a correlation coefficient (Kendall's Tau-b) of .327 with a significance value of <0.001). Finally, there was an interesting correlation between how respondents ranked the complexity of the three most complex features with the frequency with which they used those features (See table 5.18). Namely, the results showed that the more often you use a feature the less complex you would view that feature.

Table 5.18 *Correlation of feature ranking to frequency of feature usage – three most advanced features only*

Comparison	Correlation (using Kendall's tau B)	Significance
Usage of sharing references to the ranking of complexity for sharing feature	.178	< .001
Usage of annotations to the ranking of complexity for annotations feature	.237	< .001
Usage of custom integration to the ranking of complexity for integration feature	.234	< .001

IDT Classification

From the four items that loaded to the same component in the PCA, an innovativeness composite metric was created. This composite measure was used to classify the respondents into the classical adopter groupings. From the literature a practice is to combine the innovators with the early adopters due to their smaller group size (Mahajan et al., 1990). Dividing loosely normal distribution shaped data created four different groups as seen in table 5.19. Taking the innovativeness composite measure four adopter cohorts were created using threshold values of less than 4 for laggards, from 4 to 5.49 for late majority, from 5.5 through 6.49 for early majority, and greater than 6.5 for the early adopter / innovator cohort as shown below. There were six cases in which missing data prevented the calculation of the full innovativeness composite metric. These six cases were handled by the process of substituting the mean of the scale for the missing variable. This resulted in the six cases being classified as late majority.

Table 5.19 *IDT Cohort Classification*

Adopter Group	Frequency	Percent
1-Early Adopter	65	16
2-Early Majority	131	33
3-Late Majority	139	35
4-Laggard	63	16
Total	398	100.0

Cross-tab Analysis

The core cross-tab analysis that was performed was between adopter category and degree of usage of RM software. The results are depicted in table 5.20 below. As expected, the overall result shows that the degree of usage of RM software was significantly higher for innovators compared to laggards.

Table 5.20 *Cross-tabulation of adopter group and the degree of RM usage*

	Degree of Usage of RM Software							
Cohort	Never	Almost Never	Infrq.	Some-times	Often	Almost Always	Always	Total
Early Adopters	1	3	5	4	6	15	31	66
Early Majority	17	12	8	11	15	25	43	137
Late Majority	29	13	9	14	19	26	29	141
Laggard	19	4	8	8	5	9	10	65
Total	66	32	32	37	45	75	113	398

(Chi-square .001, Kendall's tau-b < .001)

Survey Open-ended Questions

The survey asked also a number of general open-ended questions. When asked for general comments about technology roughly 30% of the respondents highlighted the importance of technology being useful as a tool to accomplish a task either easier than in another way, or, to accomplish functions not possible in another way. The remaining general comments were divided evenly amongst a variety of other topics with no one grouping comprising more than 10% of the total comments (e.g. scepticism about technology, importance of training or support, proved or tested by others prior to adoption or general positive comments about technology).

Adopters of RM software were also asked two general questions about what they liked or disliked about the software. Figure 5.1 shows that over 80% of the responses to the question about what users liked regarding RM software were feature-related. About 10% of the comments were regarding the simplicity or ease of use of the software and the remaining 10% were about time saving, automation or other benefits.

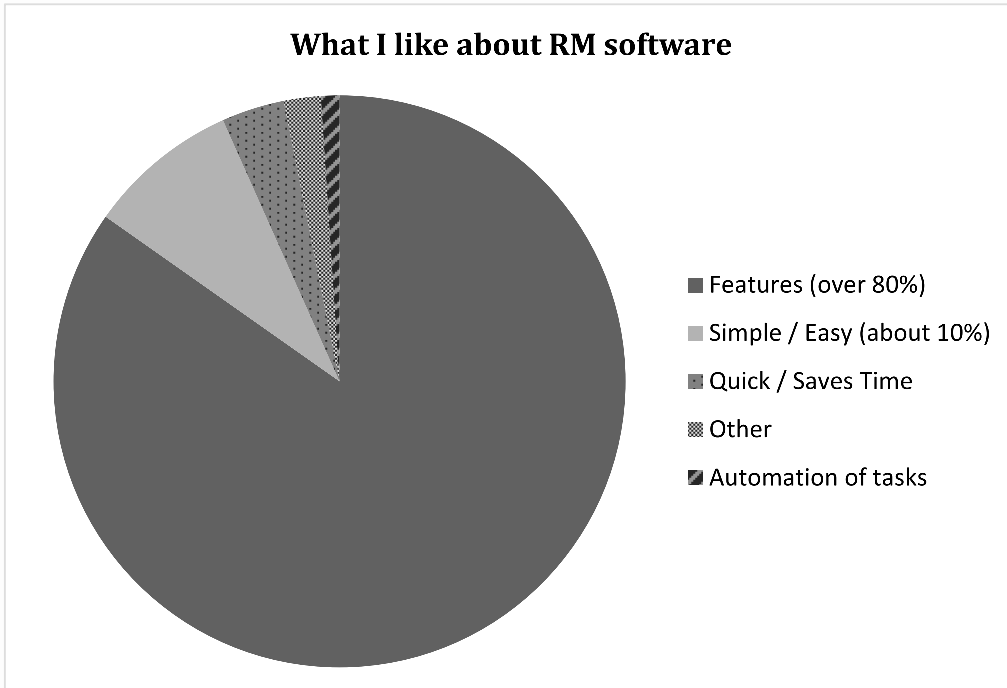

Figure 5.1 What respondents liked about RM software

The three features most liked were the ability to generate a bibliography, sorting and organizing references and documents, and centralized storing of references and articles. Collectively, they accounted for over 50% of the features identified in the comments. Respondents were also asked what they disliked about RM software. Figure 5.2 shows that general software unreliability or specific feature unreliability was the most common comment (over 40%) with usability or complexity issues (20%) second most common.

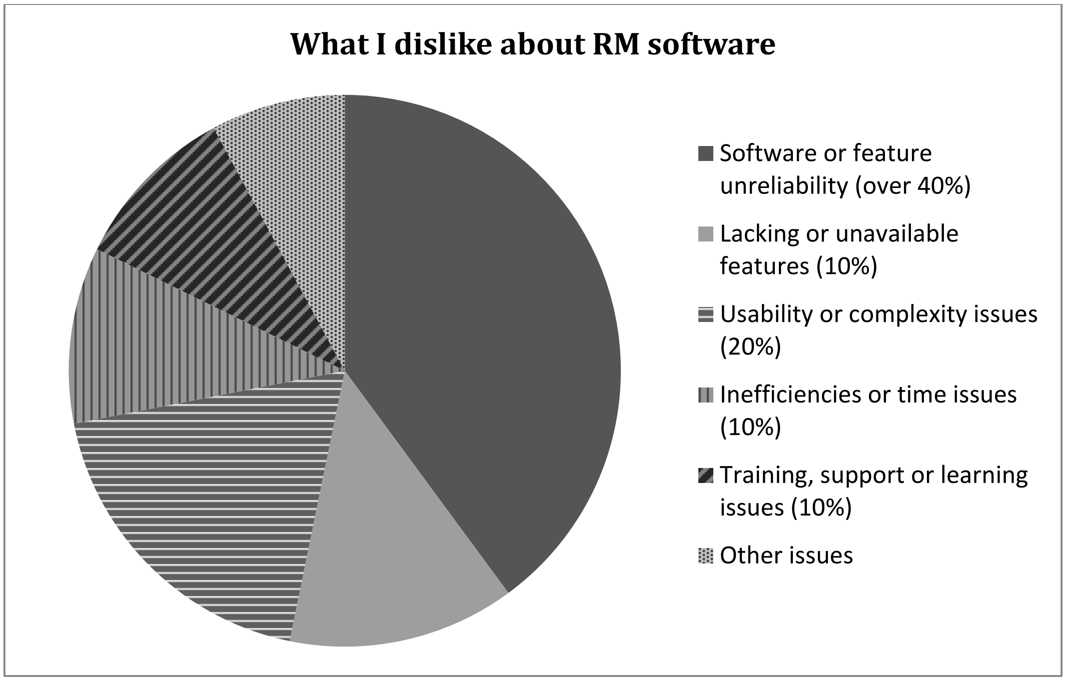

Figure 5.2 What respondents disliked about RM software

Non-adopters of RM software were asked why they did not use this software. Over 50% of the responses (see figure 5.3) indicated that they felt they had no need for the software, it did not perform the tasks any better, or they preferred an alternative method of accomplishing the tasks. Approximately 30% of the responses indicated that they were unfamiliar with or unaware of RM software. The remaining comments identified that either they tried RM software and did not like it or that the time or cost to access the software was not worth it.

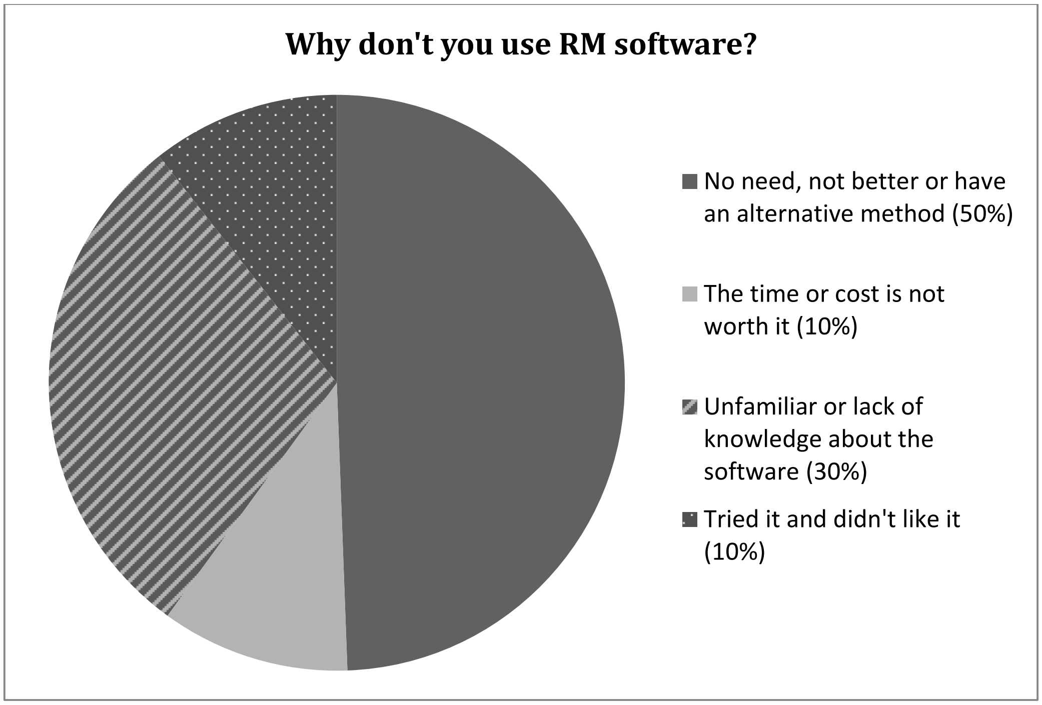

Figure 5.3 Stated reasons for not adopting RM software

Broad Interview Findings

The following tables (5.21 and 5.22) represent the key findings from the additional interviews in this study. Interviews labelled with letters were phone interviews while interviews labelled numerically were e-mail interviews. Three main descriptor groups from the interviews were identified and explored. These were adoption rationale, usage and complexity. Themes were identified in accordance with the analysis process described earlier. Within each group specific themes are documented as shown in table 5.22. Sample representative quotes are included below.

Table 5.21 *Interview Participant Categories*

Interview	Demographic Group	Most likely adopter cohort adopter based on self-described characteristics
A	Faculty	Early Adopter
B	Faculty	Early Majority
C	Student	Early Majority
D	Student	Innovator / Early Adopter
E	Faculty	Early Adopter / Early Majority
1	Post Doc	Early Adopter
2	Student	Early Majority
4	Post Doc	Late Majority or later
5	Student	Early Adopter
6	Student	Early Majority
8	Student	Early Adopter / Early Majority
9	Student	Early Majority

Table 5.22 *Key Descriptors from Interviews*

Item	Interviews where item was identified as a component
Adoption rationale descriptors	
Adoption based on usability	A, D, E, 2, 4, 6, 9
Adoption based on need (nature and frequency)	A, B, C, E, 1, 2, 4, 5, 6, 9
Adoption based on cost relative to value	1, 2, 4, 5, 6, C
Adoption influenced by others assessments	2, 4, 8, 9
Adoption influenced by time available	B, D, 1, 2, 8, 9
Discontinuance based on not meeting needs or low need	E, 4, 8
Usage Descriptors	
Use technology documentation	E, 1, 2, 4, 5
Use others to assist in learning or doing tasks in the software	C, 1, 4
Frequency of use related to need and effectiveness of feature	B, C, E, 5, 8, 9

Use advanced features as overall comfort increases	E, 1, 2
Complexity Descriptors	
Complexity based on "degree" of help needed	E, 1, 4, 5
Complexity based on "how likely feature won't work as expected or performed"	E, 1, 4
Complexity based on "intuitiveness" or match to other systems	C, 2, 5, 6, 8, 9
Complexity based on "effort" to use a feature (such as number of steps or particular details that need to be adhered to)	B, D, 2, 5, 6, 8, 9
Complexity based on what a feature does	B
Complexity influenced by interface with other software	A, 5, 9
Complexity based on degree of risk	A, 4

As identified in table 5.22 the adoption of a new technology is often based on need, usability or time available. The quote from respondent nine is representative of several other responses: "*Identifying a need is the main driver of when I adopt. Often this means getting so frustrated with what I currently use for the task that I can't deal with it any more (sic) and the effort of searching out something new seems worth it. Often times it might be to meet a new need in my life / workflow (i.e. starting my PhD). I'm also influenced a bit by how busy I am / how much effort or time it would require to learn something new- I may delay adopting a new tech for a bit if it seems like it's going to take more time than I currently have."*

Many respondents identified complexity as a function of the number of steps, or effort something takes or its "intuitiveness". Respondent five highlighted this with the following quote: "*I don't consider any of the feature that I use as particularly* *complex. Nothing that takes more than a couple of keystrokes/ mouse clicks. I would say a feature is complex if it requires several steps or non-intuitive usage."*

Chapter Six - Discussion

The main purpose of this research was to examine the relationship of learning taxonomies via BRT with the role of learning in the adoption of innovations as understood through IDT. Through the literature review and theoretical model it is theorized that individuals do not adopt an innovation in a consistent manner and that different adopter groups will exhibit various levels of cognition with respect to learning. IDT is identified as a model that could be used to categorize innovativeness by adopter classifications. One framework that could be used to explore the learning connection is examining the connection with a learning taxonomy. The main research question asked was: *What is the relationship between comprehension levels according to Bloom's Revised Taxonomy among different (information) technology adopter cohorts?* In order to examine this relationship, three sub-questions were involved. The findings will be discussed as they relate to the main research question and the associated sub-questions.

Respondent Sample

The estimated structure of the population the sample was recruited from was approximately 20% faculty and 70% graduate students, based on the data identified in methodology section regarding data collection. Consequently, the survey response rate resulted to be relatively consistent with the population distribution (76% graduate students, 20% faculty, 4% other). Based on the nature of the invitation and the distribution channels, this was a positive result from a high-level sampling perspective. However, the distribution of those that volunteered for the follow-up interview study was skewed to the more innovative cohort categories based on the participants' self-descriptions (one innovator, five early adopters, five early majority adopters and only one of late majority or later stages).

Sub-Question SQ1

This study sought first to use an alternative methodology than time to classify individuals into adopter categories according to SQ1: *With respect to a specific software innovation what indicators classify the degree of innovativeness by a person adopting a new technology according to the criteria of innovator, early adopter, early majority, late majority and laggard?* The component that came out of the PCA and related to innovativeness was used to create this grouping as shown in table 5.19. The indicators that loaded to innovativeness included the willingness to try new technologies; a comfort level with jargon; the frequency to which others ask them to give advice and a low fear of high tech. The survey questions that loaded successfully to innovativeness and the distribution worked well. First, specifically, the items that loaded to the innovativeness component accounted for nearly 12% of the variance from the PCA (see Appendix D2). Second, the Cronbach's alpha for the innovativeness component generated was .820. Third, as shown further below, the innovativeness composite component correlated, as theorized, to a variety of other variables. Finally, the survey items that loaded to this component were confirming previous studies (Lippert and Ojumu (2008); Birman (2005) and Mahajan, et al (1990)) as being related to innovativeness.

Sub-Question SQ2

Using a learning taxonomy as a framework the cognitive aspects of the role of learning in innovation adoption was explored. The second sub-question SQ 2 was: *With respect to a specific software innovation what indicators demonstrate the degree of comprehension and usage of a new innovation once it is adopted?* This was asked in an attempt to classify levels of cognition into three general BRT categories. Unlike the pilot study, the PCA results only enabled classification into two broad groupings (a BRT Low Order and a BRT High Order) from components associated with the BRT constructs. This is consistent with Zohar and Dori (2003) that only had two groups – high and low – in their study. The BRT Mid Order items instead loaded into a larger group with the BRT Low Order items. This uncertainty of classification due to complexity was not wholly unexpected after the pilot study and is consistent with some of the general limitations and issues with taxonomies as described by Anderson and Krathwohl (2001), Neumann and Koper (2010), Meyer et al. (1993) and McCarthy and Tsinopoulos (2003) as mentioned earlier in the literature review. This may have been further compounded by the nature of the innovation (Reference Management software) studied in general. As a result, the ability to segment usage into all six cognitive levels of BRT was challenging as this software is designed for practical reasons to have most features fit into the application stage of BRT. However, the loosely hierarchal nature of BRT was supported by the findings through the generation of two components – basic and advanced. The mean composite score for the BRT Low Order item was 5.15 and the BRT High Order item was 3.71 supporting the greater likelihood of mastery at lower order functions than higher order functions. Further, the correlation value of those two composite measures was moderately high – i.e., 0.424. However, these two composite measures address different constructs supported in the data-driven PCA and through the theoretical framework for the cognitive dimension of BRT and neither should be discarded despite the moderately high correlation.

Relative to the knowledge dimension of BRT, most of the activities of the users as they interacted with the software would be indicative of the procedural level, such as the survey items asking about proficiencies with certain features. They are less applicable to the factual, conceptual or meta-cognitive levels. That being said, the qualitative interviews allowed the exploration of the meta-cognitive processes in the decision making stage of the adoption process.

Sub-Question SQ3

The literature review and theoretical model postulated that different adopter groups could have different characteristics as well as not adopting in a consistent manner. Sub-question three (i.e., *With respect to a specific software innovation how do the different cohorts in IDT adopter categories exhibit degrees of usage as characterized by BRT?)* was more complex and relied upon the proposition suggested in the model to investigate. The research proposition stated: *the higher the degree of innovativeness the more likely an individual is to demonstrate greater frequency of activities at the higher order cognitive levels of Bloom's taxonomy.* This proposition was supported statistically but not as strong as a correlation as it was found in the pilot study (where it was 0.462). In the full study the Pearson correlation between the innovativeness composite measure and the BRT High Order was only 0.229, however it was still found to be statistically significant (p-value of .001 or better). Therefore, the null hypothesis for this proposition is rejected and thus innovativeness is correlated to the frequency of activities at the higher order of BRT.

Overall, sub-question SQ 3 had mixed answers. While innovativeness resulted to be correlated to the BRT Low and BRT High order composite measures, the two broad levels of BRT that were identified in the analysis came out more strongly correlated with each other. This generates evidence that the presence of higher order BRT cognitive functions are more strongly correlated to the presence of lower order BRT cognitive functions than it was to the degree of innovativeness of the respondent. The finding of innovativeness being correlated to higher order measures while not being exclusive from lower order measures is in line with findings of Zohar and Dori's (2003) study relating that high and low achievers both show higher order activities. Just as low achievers can operate within higher order cognitive activities individuals with lower degrees of innovativeness can still operate at higher order cognitive levels. Thus, to help the adoption process encouraging users to operate at higher order levels is important regardless of their degree of innovativeness - as long as it is engaged with activities at a lower order level as well. Additionally, the higher the degree of innovativeness the more likely they will be able to move through all cognitive levels in the usage of the innovation.

Discussion Regarding Other Findings

Another notable result was that the IDT classification was highly, and significantly, connected to the general rate of adoption of RM software as seen with the cross-tab analysis result at a Chi-Square 0.001 significance level. This confirms the IDT literature about the nature of adopter cohorts in using new technologies (Rogers, 2003). Furthermore, the number of software programs used was also correlated to the innovativeness composite measure (.327 with p-value of <.001). This is in harmony with the IDT principle that clusters of technology, and their associated learning curves, have an effect on adopting additional technologies (Rogers, 2003). However, cross-tab analysis of age, gender, faculty status, publication frequency, years of computer experience did not yield any significant results, correlations or effects. Additionally, cross-tab analysis of the three validation questions did not yield any contravening or noteworthy results.

One interesting finding that resulted more predominantly from the interview phase of the study was a solid connection of the definition of complexity related to the literature. Over half of the interview respondents identified the importance of usability, effort and usefulness and that those characteristics strongly influenced the perception of complexity (see tables 5.20 and 5.21). This supports that complexity can be reduced with use and with expertise.

Overall, the majority of the findings are consistent with the literature. Both the quantitative and the qualitative investigations confirmed, or were consistent with, a number of the factors and sub-factors such as social systems, communication, compatibility, and complexity (Rogers, 1962) that were identified in the literature review. For example, the propensity to adopt was influenced by the adopter group to which the potential user most closely associated with. Additionally, with respect to the IDT principles of relative advantage, complexity and compatibility (Rogers, 2003; Frambach, 1993), this study confirmed that those factors are reasons for people to adopt or not adopt.

In addition to the findings relative to complexity being consistent with IDT, these findings regarding complexity, ease of use and usefulness are consistent with TAM (Davis, 1986, 1989). Specifically, the degree of the use of the technology was indicated as part of the decision making process (Davis, 1986). Furthermore, results in the open-ended responses of the online survey and in the qualitative phase (shown in figures 5.1, 5.2 and 5.3 and tables 5.21 and 5.22) confirm the perception of the ease of use and the perceived usefulness of the adoption as adoption factors. These are the two most foundational components of the TAM model (Davis, 1986, 1989). Effort expectancy is a core aspect to the UTAUT model of adoption (Venkatesh, et al., 2003) and was found to be relevant in the results of this study. Other findings from the interview phase were consistent to the literature showing that innovators tend to ignore the documentation a bit more than the other cohorts (Moore, 2001). Ongoing usage and retention is influenced by perceived ease of use and usefulness (TAM (Davis, 1986, 1989)) and ongoing usage is influenced by relative advantage and complexity (IDT (Rogers, 2003)).

Overall, the answer to the main research question, *What is the relationship between comprehension levels according to Bloom's Revised Taxonomy among different (information) technology adopter cohorts?,* was shown to demonstrate a weaker connection than theorized based on the literature review. There is indeed a relationship in that the degree of innovativeness is correlated to the comprehension levels according to BRT. The greater the innovativeness the more likely higher order functions is to be demonstrated. Statistically significant, (p-value of 0.001 or better), innovativeness has a small correlation (applying Cohen's (1988) scale for social sciences for a coefficient of 0.229) with BRT High Order functions. Given the number of factors involved in the innovation adoption process, as well as the complexity in measuring cognition levels according to BRT, this is not especially surprising. The evidence that learning does indeed have a role in the adoption process is consistent with the literature and the theoretical model. Further, the fact that people do not adopt in a consistent manner and do exhibit differences with respect to feature use was demonstrated by the findings. Overall, this result does have implications for theory and for practice.

Significance of the Research Question

Successful adoption of a new technology in an organization is critical to accelerating the perceived and anticipated benefits of the innovation into the daily activities of that organization. Additionally, the positive benefit of the technological investment can be reduced by a poor adoption and un-sustained use. A strategy to deal with the rate of change of new technologies makes this a timely research problem. Also, this research will help define connections that could be used to accelerate the adoption of a new technology, or to enhance the continuation of a technology. The amount of effort and funding required making good use of new technology adoptions is significant in our society (Jasperson et al., 2005; Tyre & Orlikowski, 1993) and successful adoption rates are not always strong (Lee & Xia, 2005). While initial use is important, there is also the importance of post-adoption behaviour (Jasperson et al., 2005) and reaching a critical mass of adopters (Moore, 2001; Roger, 2003) that are key components to making the diffusion of the innovation process self-sustaining. One important benefit is that this research can assist organizations that make a heavy investment in a new technology realize their goals and objectives; therefore, this has financial and efficiency benefits. At the individual level, this may assist in accelerating the rate that individuals benefit from new (and positive) technologies (Hartwick & Barki, 1994). Overall, a significant approach to improve adoption success is to facilitate knowledge transfer as described below in the implications for theory and for practice.

Implications for Theory

From a *theoretical perspective* this research accomplished three main results. First, this study implemented new constructs for quantitative study on IDT that did not depend on a time-based classification of IDT adopter cohorts. Thus, the instrument decoupled the time classification schema allowing potentially more effective or applicable options to be used. Second, the study examined the degree of usage from a learning taxonomy point of view. As postulated, it appears theoretically possible to apply BRT to cohorts in the adoption curve. The findings demonstrated that BRT High Order activities are correlated to BRT Low Order activities. However, BRT can only loosely be applied to the cohort characteristics in how they use, and to what degree that they use, a new innovation. Third, the study showed that the degree of innovativeness by the adopter was correlated to both BRT Low Order and BRT High Order. While the nature of lower order activities (remembering and understanding) is different from higher order activities (creating and evaluating) there is a relationship to innovativeness for both.

Implications for Practice

As identified at the outset of the dissertation the time and cost implications of failed adoptions is a historic issue. There are a number of findings with *practical applications* from the results of this study. One, the correlation results highlighted that the importance of performing and mastering the basic features is critical to being able to perform the advanced features in the software. This is true even if the tasks in the basic features are largely unrelated to the advanced features. Even the innovators' results demonstrate that these two features are correlated and while innovators may be able to progress in less time the need to progress through the orders of BRT are important. Thus, the learning process cannot easily skip the foundation knowledge. Two, the role of learning was identified as being important, but not the sole determinant of successful adoption and demonstration of the higher order functions. This means that training cannot solely resolve adoption concerns. Other factors in IDT such as trialability, observability, relative advantage and compatibility must still be considered to facilitate a successful adoption, in addition to training. Three, the qualitative findings demonstrate that while many influences might exert on the decision to adopt, familiarity and knowledge about the innovation are almost as significant as the innovation meeting a need of the adopter. Therefore, the innovation adoption process must have a knowledge transfer component. It is in this manner that the findings can help reduce the time and cost implications of adoptions that fail or are partially successful.

Limitations

There are a number of potential limitations to this study. These include limitations due to sample and context, limitations due to methodology and limitations due to theory restrictions. First, the sample was subject to self-selection bias due to the online administration of the survey as well as the limitation to an academic population with a technology adoption. Additionally, due to the inability to randomly select from every member of the population of interest a referral system was used. To minimize the effect of this limitation the main body of referral requests were sent to forty institutions randomly selected thus ensuring the randomization of institutions. The other methods of referral requests were sent to all identifiable referrers in the sub-groups of the population as described in the methodology. Second, there are a couple of methodological limitations. For example the, classifications into the innovation adopter categories was developed from the composite innovativeness metric and the study did not distinguish between all six categories in BRT but only broader categories of cognitive activities. Third, this study limited its analysis to the cognitive domain component of BRT and this creates an opportunity for additional research at a later time. It is also subject to the individual-blame bias critiques in the IDT model that those who adopt later are considered lesser or not as educated or wise.

Future Research and Directions

Simplistically, the results demonstrated a pattern of mastery according to the definitions of BRT that were correlated to the IDT category the adopters belong to. However, the results of this study provided additional areas for further investigation that could hone the nature of the application of learning activities designed to support a technology innovation adoption. Furthermore, a study could be explicitly designed to determine the direction of causality in the correlated relationship.

Future research possibilities with other innovation models

Regarding the correlation that was revealed about the influence of user's proficiencies in the basic components on the user proficiencies of the advanced components is that the TAM model (Davis, 1986, 1989) may be an alternate approach to the IDT model in explaining that finding. The connection with IDT theory does exist, but it is not in isolation, and that is where TAM might add to the picture. Additionally, TAM could add context to the influence of adopting technologies in the same cluster. As well, future research could explore specifically how the Theory of Reasoned Action could also explore the relationship between the adoption of innovations and learning theories.

Future research possibilities related to learning experiences

There were two domains included in BT that were not investigated in this study that would be candidates for future research on this same line of investigation concerning the affective domain and the psychomotor domain. Also, the study did not reveal any data on how people learned to use the software or how they may or may not have opportunity to teach others. This is an important component of the topic from the literature but the study was limited in scope to personal use of the RM software. Finally, other learning models could be used as a framework instead of learning taxonomies to investigate the role of learning in innovation adoption.

Future research possibilities related to innovation type and complexity

Additionally, another perspective that could be explored is the effect of sustaining innovations, or those that are more incremental or evolutionary in nature, versus disruptive innovations or those that are revolutionary, radical or discontinuous to existing technologies (Christensen, 1997; Yu & Hang, 2010; Christensen & Raynor, 2013). Generally, RM software is more a sustaining innovation than a disruptive innovation in that its purpose is to increase the efficiency of existing practices more than it changes the process of academic writing or research production. Given the connection between learning and adoption and the identified influence of clusters of technology, it is highly likely that we would see different effects, and potentially different levels of cognition according to BRT definitions between the adoption of an innovation that is considered sustaining versus one that is considered disruptive. While this line is not easily demarcated, there is a continuum that could be explored relative to the nature of the innovation as per the classification of sustaining or disruptive.

Furthermore, beyond the purpose of the dissertation research identified above, this study has a number of wider implications that could be explored. Innovation is not restricted to adopting a technology, but can expand to the adoption of products in general. It also can be related to adopting a service or a process (Rogers 2003; also personal communication, Christensen. C, December 2012). Therefore, while this study is focused on a technological innovation, it could be expanded to other types of innovation including process innovations or conceptual innovations. This implies that this line of research can expand beyond the marketing of a new product, or beyond the implementation of a new technology system, to other uses in business, health care, education, and defence (Moore, 2001; Rogers, 2003).

Finally, a line of exploration could be the investigation of a concept of “relative complexity” where the perception of the complexity of features is subject to a variety of conditions such as those identified in the interview phase of the study including intuitiveness, risk level and level of interface with other technology.

Chapter Seven - Conclusion

This dissertation explored how the cognitive theory embedded in learning taxonomy interfaces with the different traits of the adoption cohorts in IDT within the context of a technology software for academia. As identified in the literature review and confirmed in this study, one factor involved in Rogers' innovation diffusion theory (IDT) is knowledge transfer. It is knowledge transfer in IDT that connects to knowledge and cognitive processes in BRT and, therefore, connects these two frameworks. By connecting these two frameworks we now are able to better understand the adoption of an innovation from the perspective of learning. Strategically this connection between learning taxonomy and technology adoption is important but is only one of the many factors involved in the diffusion of innovation. Further, the mastery of lower order functions is a very significant driver of the ability to master higher order functions in a new technology. Once mastered, and used more frequently, our perception of the activity is that it is less complex. Through this mastery and improved knowledge transfer, adoptions will have a greater chance of success, and overall we can minimize the time and cost implications in partially successful adoptions.

In summary, this study contributed to the body of knowledge by investigating the relationship in a way not previously performed. However, there are limitations to the contribution due to sample selection, methodology and theory restrictions. As a result, there are future research opportunities by exploring the role of learning in innovation adoption. By using other models for innovation adoption or learning, other types of innovation or other domains of learning more could be understood. When considering knowledge transfer and the learner in innovation adoption processes there are learning related factors that can facilitate adoption. However, innovation adoption is a complex phenomenon and BRT as a formal theory only could account for part of the process. The cognitive aspect of learning is a significant, albeit a relatively low level, contributor to the overall adoption process.

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Appendices

Appendix A – Learning Taxonomy Appendices

Appendix A1: Gagne and Briggs (1974) nine events

1. Gaining attention
2. Informing the learner of the objective
3. Stimulating recall of pre-requisite learning
4. Presenting stimulus material
5. Providing learner guidance
6. Eliciting the performance
7. Providing feedback about performance correctness
8. Assessing the performance
9. Enhancing retention and transfer

Appendix A2: The SOLO taxonomy categories (Biggs & Collis, 1982)

1. Pre-structural
2. Unistructural
3. Multi-structural
4. Relational
5. Extended Abstract

Appendix A3: Lambe's (2007, p. 199) nine validation criteria for taxonomies

1. Intuitive
2. Unambiguous
3. Hospitable
4. Consistent and predictable
5. Relevant
6. Parsimonious
7. Meaningful
8. Durable
9. Balanced

Appendix A4: Bloom's taxonomy – cognitive domain (Bloom et al., 1956)

1. Knowledge
    1.1. Knowledge of specifics
        1.1.1. Knowledge of terminology
        1.1.2. Knowledge of specific facts
    1.2. Knowledge of ways and means with dealing with specifics
        1.2.1. Knowledge of conventions
        1.2.2. Knowledge of trends and sequences
        1.2.3. Knowledge of classifications and categories
        1.2.4. Knowledge of criteria
        1.2.5. Knowledge of methodology
    1.3. Knowledge of universals and abstractions in a field
        1.3.1. Knowledge of principles and generalizations
        1.3.2. Knowledge of theories and structures

2. Comprehension
    2.1. Translation
    2.2. Interpretation
    2.3. Extrapolation

3. Application

4. Analysis
    4.1. Analysis of elements
    4.2. Analysis of relationships
    4.3. Analysis of organizational principles

5. Synthesis
    5.1. Production of a unique communication
    5.2. Production of a plan, or proposed set of operations
    5.3. Derivation of a set of abstract relations

6. Evaluation
    6.1. Judgments in terms of internal evidence
    6.2. Judgments in terms of external criteria

Appendix A5: Bloom's revised taxonomy (Anderson & Krathwohl, 2001)

Knowledge Dimension	Cognitive Process Dimension
A. Factual Dimension a. Knowledge of terminology b. Knowledge of specific details and elements	1. Remembering 1.1. Recognizing 1.2. Recalling
B. Conceptual Knowledge a. Knowledge of classifications and categories b. Knowledge of principles and generalizations c. Knowledge of theories, models and structures	2. Understanding 2.1. Interpreting 2.2. Exemplifying 2.3. Classifying 2.4. Summarizing 2.5. Inferring 2.6. Comparing 2.7. Explaining
C. Procedural Knowledge a. Knowledge of subject-specific skills and algorithms b. Knowledge of subject-specific techniques and methods c. Knowledge of criteria for determining when to use appropriate procedures	3. Applying 3.1. Executing 3.2. Implementing
D. Metacognitive Knowledge a. Strategic knowledge b. Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge c. Self-knowledge	4. Analyzing 4.1. Differentiating 4.2. Organizing 4.3. Attributing
	5. Evaluating 5.1. Checking 5.2. Critiquing 6. Creating 6.1. Generating 6.2. Planning 6.3. Producing

Appendix B – Model Development Appendices

Appendix B1: Features list for Reference Management (RM) software

A common feature list of reference management software according to the study by Gilmour and Cobus-Kuo (2011) follows:

- storing references
- searching and organizing references
- creating bibliographies
- annotation
- migration and sharing references
- word processor integration

These features were compared to features listed in two of the most commonly used RM software websites (RefWorks - www.refworks.com and Mendeley – www.mendeley.com) as well as comparison to a blog review on RM software for content validation. Two additional features that included are the sharing and collaboration features.

Appendix B2: Initial quantitative survey instrument

Connecting Dots: Using Learning Taxonomy to Enhance Understanding of Innovation Adoption

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Information and Consent

This survey is a study conducted by a Doctoral student at Athabasca University as part of a Doctorate of Business Administration dissertation research. The title of the proposed dissertation is "Connecting Dots: Using Learning Taxonomy to Enhance Understanding of Innovation Adoption". The student researcher is Richard Rush (rushr@uvic.ca) and the academic supervisor is Dr. Mihail Cocosila, Associate Professor at Athabasca University (mihailc@athabascau.ca). The completed dissertation will be listed in an abstract posted online at the Athabasca University Library's Digital Thesis and Project Room; and the final research paper will be publicly available. The purpose of this survey is to explore the relationship between technology adopter characteristics and software use characteristics related to reference management (RM) software. You are being invited to participate as a potential user of reference management software that could provide feedback on the field testing of the questions. There are no known risks for participating, nor will any identifying information be obtained through this online survey and your participation is completely anonymous and voluntary. There are no right or wrong answers - please answer the questions according to your perceptions. The survey is expected to take approximately 20 minutes to complete and if you desire you can exit the survey at any time. This study has been reviewed by the Athabasca University Research Ethics Board. Should you have any comments or concerns regarding your treatment as a participant in this study, please contact the university's Office of Research Ethics at 780-675-6718 or by e-mail to rebsec@athabascau.ca .If you have read and understood the information contained in this introduction and you agree to participate in the study, on the understanding that you may refuse to answer certain questions and may withdraw during the data collection period, you may now proceed to the survey.

Questionnaire

Do you regularly use a reference management tool or software?

- ○ Yes
- ○ No
- ○ Not Sure

Which tool do you use (Pick the primary tool if you use more than one)?

- ○ RefWorks
- ○ Mendeley
- ○ EndNote
- ○ Zotero
- ○ Other (Specify) ________________________

How long have you used RM software (number of years)?

[ ]

How many previous versions of the software have you used?

[ ]

Do you use the most current version of the reference management software?

- ○ Yes
- ○ No
- ○ Not Sure

Do you use any advanced or add-on modules that are not part of the standard package for your reference management software?

- ○ Yes
- ○ No
- ○ Not Sure

Please indicate your answer which best represents your perceptions for each of the statements below.
The main reason I use RM software is to keep track of the articles I have read.

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

I can explain the features of my RM software to others.

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

I navigate proficiently through the menus in my RM software to find the features I wish to use

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

Do you use your RM software to share references electronically with your colleagues?

- ○ Almost always
- ○ Often
- ○ Sometimes
- ○ Infrequently
- ○ Almost never

Do you use your RM software to generate a reference list or bibliography?

- ○ Almost always
- ○ Often
- ○ Sometimes
- ○ Infrequently
- ○ Almost never

Do you use your RM software to organize (sort) references?

- ○ Almost always
- ○ Often
- ○ Sometimes
- ○ Infrequently
- ○ Almost never

I use the annotating and notes section of my RM software in order to keep myself organized.

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

I use the RM software to select the best references and articles amongst a large collection of possible references

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

When I co-author we ensure that all the authors use the same RM software in order to share and migrate resources to each other.

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

Do you customize your RM software output style to integrate with a word processing program to meet specific needs of colleagues or the task?

- ○ Yes
- ○ No
- ○ Not Sure

If you answered yes to the preceding question, did you need others to assist you to integrating the two?

- ○ Yes
- ○ No
- ○ Not Sure

Please indicate your answer which best represents your perceptions for each of the statements below.
I can explain to others the steps for the main features of RM software

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

I use my RM software to enter in my references as I find them during all stages of my academic writing.

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

As part of my academic writing I create folders in the RM software and organize my references to match sections of my paper.

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

I use my RM software seamlessly throughout my academic writing process integrating its uses at all stages from draft through to final edits.

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

Please rank in order the following features of RM software in terms of perceived complexity.

	most complex	2nd most complex	3rd most complex	4th most complex	5th most complex	6th most complex
store references	○	○	○	○	○	○
organize references	○	○	○	○	○	○
creating a bibliography	○	○	○	○	○	○
sharing references electronically	○	○	○	○	○	○
making and storing notes	○	○	○	○	○	○
integration with a word processing program	○	○	○	○	○	○

Please indicate your answer which best represents your perceptions for each of the statements below.
My knowledge of computers was enough for performing the functions required within the RM software.

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

Section Heading

I like to try new technologies just to see if they work.

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

I am comfortable with using and understanding technical jargon.

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

I have high expectations for new technologies.

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

I look at the technology for what it can do from a work perspective.

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

I am often asked for advice on technology.
- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

Product quality is important in the decision to use or recommend the new technology.
- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

I look to other people, whose opinions I respect, for recommendations when buying new technologies.
- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

The costs of high-tech products are not worth the money invested.
- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

The availability of support services is important in the decision to use the new technology.
- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

I have a fear of high-technology products.
- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree
- ○ Strongly Disagree

I believe most new technology will fail.
- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree or Disagree
- ○ Disagree

- ○ Strongly Disagree

Are you currently a student?
- ○ Yes
- ○ No

Which level of degree are you undertaking?
- ○ Masters
- ○ Doctorate
- ○ Other (specify) ______________________

Are you currently a faculty member?
- ○ Yes
- ○ No

What level of faculty are you?
- ○ full professor
- ○ associate professor
- ○ assistant professor
- ○ adjunct or sessional lecturer
- ○ Other (specify) ______________________

How many research projects or articles are you currently working on?

[ ]

Have you published in a journal?
- ○ Yes
- ○ No

Number of journal publications in the last 7 years
- ○ 3 or less
- ○ 4 to 7
- ○ 8 to 12
- ○ 13 to 20
- ○ 21 or more

How many years have you been using a computer?

[ ]

How many different types of software do you use regularly in the academic setting?
- ○ 3 or less
- ○ 4 to 7
- ○ 8 or more

How many hours do you spend per week on some type of a personal computer, tablet or e-reader?
- ○ less than 1
- ○ 1 to 10
- ○ 11 to 20
- ○ 21 to 30
- ○ 31 or more

What is your age?

- ○ 25 or younger
- ○ 26-35
- ○ 36-45
- ○ 46-55
- ○ 56 or older

What is your gender?

- ○ Female
- ○ Male

Additional Questions

What do you like about RM software?

What do you dislike about RM software?

Do you have any comments in general that you would like to share about RM software?

Do you have any comments in general that you would like to share about technology?

Do you have any comments in general that you would like to share about this study?

Survey Improvement Questions (for Pilot only)

How did you feel about the survey length?

Which questions did you find it difficult or impossible to answer? Why?

Did you feel the set of questions on RM usage were appropriate?

Do you have any survey layout or wording improvement recommendations?

Appendix B3.1: Changes between initial and final instrument and rationale

Change	Rationale
General Changes	
Reordering of some questions within the survey.	This was intended to provide better flow in question types where possible including reversing the technology and BRT groups and better grouping demographic questions
Some slight wording modifications within questions regarding positional statements	This was to match the updated ordering
Various grammar and spelling corrections	Improve quality and clarity
Added “not applicable” to Likert questions	Allows users without an opinion or perspective to opt out
Likert scale changed to seven point	To allow greater sensitivity at the item level
Frequency scale changed to seven point	To allow greater sensitivity at the item level
Changes to Specific Questions	
Do you regularly use a RM software from (y/n/not sure to categorical frequency question)	To obtain greater sensitivity to degree of use
Segregated the age data to 5 year increments over 10 year increments	To obtain greater sensitivity
Segregated the # of software further to get four groups	To obtain greater sensitivity
Reworded the question asking if you needed others to assist you in customizing the output	To improve question clarity based on feedback
Added a not sure to number of publications question	Allows users that are unsure to respond as such
Removed “to match sections of my paper” in the question “As part of my academic	Reduce the degree to which the question was double-barreled

writing I create folders in the RM software and organize my references to match sections of my paper."	
Aligned the complexity ranking question better to the other questions	Some of the terms were inconsistent with terms used on similar questions elsewhere in the survey and caused confusion
Modified "store references" usage question wording	The terms were inconsistent with terms used on similar questions elsewhere in the survey and caused confusion
Added open ended on why they use RM software or why not	Adds to the ability to triangulate the results
Questions Removed	
Removed question re how many previous versions	The years using RM software was very highly correlated with this result and there were many that responded "not sure" of the number
Removed "I use my RM software to enter in my references as I find them during all stages of my academic writing."	Overlap with other questions with strong likelihood of multi-collinearity
Removed question "do you use the most current version"	There was a high degree of "not sure" data
Removed "I can explain the features of my RM software to others."	Overlap with other questions with strong likelihood of multi-collinearity
New Questions	
Added a why don't you use the software question	Intent to gain better understanding of non-adoption
In the question which asked which tool they used - added "don't use a tool"	Just in case they answered yes to previous by accident – will be used as a verification question

Appendix B3.2: Final quantitative survey instrument mapping table

The following represents the quantitative survey instrument created as a result of findings from the literature review, the methodology review and the results of the pilot study. Some of these questions have been drawn from empirical research and the literature review. The fifth column in the table below indicates if there was a specific source for a question and if the question was used exactly as in the source or adapted. Some demographic questions are indicated "common" if they are ubiquitous to many instruments. If this fifth column is blank the question is proposed by this survey. However, where more than one study uses a similar question and exact wording is selected from one of them then the study with exact wording is noted. The sixth column identifies the construct measured. As many questions were adapted slightly from their source format, or combined with items from other studies construct reliability was tested in this study (see Appendix D3.1) rather than trusting previous reliability values.

Question Number	**Question Wording**	**Response range**	**Type** **Note 1**	**Question Source** **Adapted, Exact or Common**	**Construct and/or proposition measured**
		General Technology			
T1	How many hours do you spend per week on some type of a personal computer, tablet or e-reader?	• less than 1 • 1-10 • 11-20 • 21-30 • 31-40 • 41 or more	C	Mahajan et al (1990). (adapted)	Demographic

T2	How many years have you been using a computer?	Numeric	R	Halawi, Pires and McCarthy (2009), Birman (2005) (exact)	Demographic
T3	How many different types of software do you use regularly in the academic setting?	• 2 or less • 3-5 • 6-8 • 9 or more	C	Foasberg (2011) (adapted); Mahajan et al. (1990) (adapted)	Demographic
		Technology Adopter Category			
TA1	I like to try new technologies just to see if they work.	Likert		Lippert and Ojumu (2008) (exact)	Innovativeness
TA2	I am comfortable with using and understanding technical jargon.	Likert		Birman (2005) (adapted)	Innovativeness
TA3	I am often asked for advice on technology.	Likert		Mahajan, et al (1990). (adapted)	Innovativeness
TA4	The costs of high-tech products are not worth the money invested.	Likert		Lippert and Ojumu (2008) (exact)	Innovativeness (reverse coded)
TA5	I have a fear of high-technology products.	Likert		Lippert and Ojumu (2008) (exact)	Innovativeness (reverse coded)
TA6	I believe most new technology will fail.	Likert		Lippert and Ojumu (2008) (adapted)	Innovativeness (reverse coded)

TA7	I have high expectations for new technologies.	Likert		Lippert and Ojumu (2008) (adapted)	Personal Technology Expectations
TA8	I look at the technology for what it can do from a work perspective.	Likert		Lippert and Ojumu (2008) (adapted)	Personal Technology Expectations
TA9	Product quality is important in the decision to use or recommend the new technology.	Likert		Lippert and Ojumu (2008) (exact)	Quality and Reference Importance
TA10	I look to other people, whose opinions I respect, for recommendations when using or buying new technologies.	Likert		Lippert and Ojumu (2008) (exact)	Quality and Reference Importance
TA11	The availability of support services is important in the decision to use the new technology.	Likert		Lippert and Ojumu (2008) (adapted)	Support Reliance
		Summary Technology			
T4	Do you have any comments in general that you would like to share about technology?	Open text	T		General Usage
		General RM Usage			
RM1	Do you use a reference management tool or software?	Always Almost always Often Sometimes Infrequently Almost never Never	C		Demographic
RM2a	(If never was answer to previous the respondents will be given this question	Open text	T		General Usage

	and then redirected to the technology group of questions) What is the primary reason you do not use RM software?			
RM2b	(If they use RM software at all the respondents will be given this question and then continue in this group of questions) What is the primary reason you use RM software?	Open text	T	General Usage
RM3	Which tool do you use (Pick the primary tool if you use more than one)?	1. RefWorks 2. Mendeley 3. Endnote 4. Zotero 5. Other (Specify) 6. Don't use a tool	C	Demographic
RM4	How long have you used RM software (number of years)?	Numeric	R	Demographic
RM5	Do you use any advanced or add-on modules that are not part of the standard package for your reference management software?	y/n/not sure	C	Demographic
Software feature usage questions to identify complexity use according to BRT				
BRT1	Do you use your RM software to keep track of the articles you have read?	Always Almost always Often Sometimes Infrequently Almost never Never		BRT Low Order

BRT2	I can explain to others the main features of RM software	Likert		BRT Low Order
BRT3	I navigate proficiently through the menus in my RM software to find the features I wish to use	Likert		BRT Low Order
BRT4	I use the annotating and notes section of my RM software in order to keep myself organized.	Likert		BRT Low Order
BRT5	Do you use your RM software to generate a reference list or bibliography?	Always Almost always Often Sometimes Infrequently Almost never Never	C	BRT Mid Order
BRT6	Do you use your RM software to organize (sort) references?	Always Almost always Often Sometimes Infrequently Almost never Never	C	BRT Mid Order
BRT7	As part of my organizing references I create folders in the RM software.	Likert		BRT Mid Order
BRT8	Do you use your RM software to share references electronically with your colleagues?	Always Almost always Often Sometimes Infrequently Almost never Never	C	BRT High Order
BRT9	When I co-author we ensure that all the authors use the same RM software in order	Likert		BRT High Order

	to share and migrate resources to each other.				
BRT10	Do you customize your RM software to integrate with a word processing program to meet specific needs of colleagues or the task?	Always Almost always Often Sometimes Infrequently Almost never Never	C		BRT High Order
BRT11	Please rank in order the following features of RM software in terms of perceived complexity: store and track references, sort and organize references, generate a reference list or bibliography, sharing references electronically, making and annotating notes, integration with a word processing program. (1 being least complex to 6 most complex)	1,2,3,4,5,6	O		For construct definition and validity
		Overall proficiency with RM software			
RM6	My knowledge of computers was enough for performing the functions required within the RM software.	Likert		Halawi, Pires and McCarthy (2009) (adapted)	Demographic
RM7	I use my RM software seamlessly throughout my academic writing process integrating its uses at all stages from draft through to final edits.	Likert			Validation of RM6
RM8	How frequently did you need others to assist you to perform functions within the RM software?	Always Almost always Often			Validation of RM6

		Sometimes Infrequently Almost never Never			(note this question is reverse coded)
	Summary RM Questions				
RM10	What do you like about RM software?	Open text	T		General Usage
RM11	What do you dislike about RM software?	Open text	T		General Usage
RM12	Do you have any comments in general that you would like to share about RM software?	Open text	T		General Usage
	Demographic Questions				
D1	Are you currently a student?	y/n	C	Common	Demographic
D2	Which level of degree are you undertaking?	• Master's • Doctorate • Other (specify)	C	Common	Demographic
D3	Are you current a faculty member?	y/n	C	Common	Demographic
D4	What level of faculty are you?	• full professor • associate professor • assistant professor • adjunct or sessional lecturer • not a faculty member • other (specify)	C	Common	Demographic

D5	How many research projects or articles are you currently working on?	numeric	R	Common	Demographic
D6	Have you published in a journal?	y/n	C	Common	Demographic
D7	Number of journal publications in the last 7 years	• None • 1 - 3 • 4-7 • 8-12 • 13-20 • 21 or more • Not sure	I	Halawi, Pires and McCarthy (2009) (adapted)	Demographic
D8	What is your age?	• 25 and younger • 26-30 • 31-35 • 36-40 • 41-45 • 46-50 • 51-55 • 56 and over	C	Common	Demographic
D9	What is your gender?	M/F	C	Common	Demographic

Note 1: Type (C – categorical/nominal, O – ordinal, I – interval, R – ratio, T - text)
Note 2: Likert question answers will be Strongly Agree, Agree, Somewhat Agree, Neither Agree or Disagree, Somewhat Disagree, Disagree, Strongly Disagree, Not Applicable

Appendix B3.3: Final survey informed consent and instrument

Connecting Dots: Using Learning Taxonomy to Enhance Understanding of Innovation Adoption

Richard Rush

Doctoral Candidate in Business Administration, Athabasca University, richardrush@telus.net

Research Study - Connecting Dots: Using Learning Taxonomy to Enhance Understanding of Innovation Adoption Information and Consent
The purpose of this survey is to explore the relationship between technology adopter characteristics and software use characteristics related to reference management (RM) software (e.g., EndNote, Mendeley, RefWorks, Zotero). You are being invited to participate in this survey as a potential user of reference management software that could provide a valuable perspective. There are no known risks for participating, nor will any identifying information be obtained through this online survey. Your participation is completely anonymous and voluntary. There are no right or wrong answers - please answer the questions according to your perceptions. The survey is expected to take approximately 20 minutes to complete and, if you desire, you can exit the survey at any time. This survey is part of a study conducted by Richard Rush, Doctoral candidate in Business Administration at Athabasca University. The academic supervisor is Dr. Mihail Cocosila, Associate Professor at Athabasca University (mihailc@athabascau.ca). The completed dissertation will be listed in an abstract posted online at the Athabasca University Library's Digital Thesis and Project Room. The final research report will be publicly available. This study has been reviewed and approved by the Athabasca University Research Ethics Board. Should you have any comments or concerns regarding your treatment as a participant in this study, please contact the university's Office of Research Ethics at 780-675-6718 or by e-mail to rebsec@athabascau.ca. If you have read and understood the information presented above and you agree to participate in the study, on the understanding that you may refuse to answer certain questions and may withdraw anytime during the data collection period, you may now proceed to the survey.

How many hours do you spend per week, on average, on some type of a personal computer, tablet or e-reader?

- ○ less than 1
- ○ 1 to 10
- ○ 11 to 20
- ○ 21 to 30
- ○ 31 to 40
- ○ 41 or more

How many years have you been using a computer?

How many different types of software do you use regularly in an academic setting?
- ○ 2 or less
- ○ 3 to 5
- ○ 6 to 8
- ○ 9 or more

For the questions below, please check the answer that best fits your perceptions.
I like to try new technologies just to see if they work.
- ○ Strongly Agree
- ○ Agree
- ○ Somewhat Agree
- ○ Neither Agree or Disagree
- ○ Somewhat Disagree
- ○ Disagree
- ○ Strongly Disagree
- ○ Not Applicable

I am comfortable with using and understanding technical jargon.
- ○ Strongly Agree
- ○ Agree
- ○ Somewhat Agree
- ○ Neither Agree or Disagree
- ○ Somewhat Disagree
- ○ Disagree
- ○ Strongly Disagree
- ○ Not Applicable

I am often asked for advice on technology.
- ○ Strongly Agree
- ○ Agree
- ○ Somewhat Agree
- ○ Neither Agree or Disagree
- ○ Somewhat Disagree
- ○ Disagree
- ○ Strongly Disagree

- ○ Not Applicable

The costs of high-tech products are not worth the money invested.

- ○ Strongly Agree
- ○ Agree
- ○ Somewhat Agree
- ○ Neither Agree or Disagree
- ○ Somewhat Disagree
- ○ Disagree
- ○ Strongly Disagree
- ○ Not Applicable

I have a fear of high-technology products.

- ○ Strongly Agree
- ○ Agree
- ○ Somewhat Agree
- ○ Neither Agree or Disagree
- ○ Somewhat Disagree
- ○ Disagree
- ○ Strongly Disagree
- ○ Not Applicable

I believe most new technology will fail.

- ○ Strongly Agree
- ○ Agree
- ○ Somewhat Agree
- ○ Neither Agree or Disagree
- ○ Somewhat Disagree
- ○ Disagree
- ○ Strongly Disagree
- ○ Not Applicable

I have high expectations for new technologies.

- ○ Strongly Agree
- ○ Agree
- ○ Somewhat Agree
- ○ Neither Agree or Disagree

- Somewhat Disagree
- Disagree
- Strongly Disagree
- Not Applicable

For the questions below, please check the answer that best fits your perceptions.
I look at the technology for what it can do from a work perspective.

- Strongly Agree
- Agree
- Somewhat Agree
- Neither Agree or Disagree
- Somewhat Disagree
- Disagree
- Strongly Disagree
- Not Applicable

Product quality is important in the decision to use or recommend a new technology.

- Strongly Agree
- Agree
- Somewhat Agree
- Neither Agree or Disagree
- Somewhat Disagree
- Disagree
- Strongly Disagree
- Not Applicable

I look to other people for recommendations when using or buying new technologies.

- Strongly Agree
- Agree
- Somewhat Agree
- Neither Agree or Disagree
- Somewhat Disagree
- Disagree
- Strongly Disagree
- Not Applicable

The availability of support services is important in the decision to use a new technology.

- ○ Strongly Agree
- ○ Agree
- ○ Somewhat Agree
- ○ Neither Agree or Disagree
- ○ Somewhat Disagree
- ○ Disagree
- ○ Strongly Disagree
- ○ Not Applicable

Do you have any comments in general that you would like to share about technology?

When reading and using references do you use a reference management (RM) tool or software (e.g., EndNote, Mendeley, RefWorks, Zotero)?

- ○ Always
- ○ Almost Always
- ○ Often
- ○ Sometimes
- ○ Infrequently
- ○ Almost Never
- ○ Never

If the respondent chose "Never" for the above they skipped to the questions below marked "non-RM user continues here"

Which tool do you use (Pick the primary tool if you use more than one)?

- ○ RefWorks
- ○ Mendeley
- ○ EndNote
- ○ Zotero
- ○ Other (Specify) ____________________
- ○ Don't use a tool

If the respondent chose "Don't Use a Tool" here they skipped to the questions below marked "non-RM user continues here"

How long have you been using RM software (number of years)?

For the questions below, please check the answer that best fits your perceptions.
I use RM software to keep track of the articles I have read.

- ○ Always
- ○ Almost always
- ○ Often
- ○ Sometimes
- ○ Infrequently
- ○ Almost never
- ○ Never

I can explain to others the main features of RM software.

- ○ Strongly Agree
- ○ Agree
- ○ Somewhat Agree
- ○ Neither Agree or Disagree
- ○ Somewhat Disagree
- ○ Disagree
- ○ Strongly Disagree
- ○ Not Applicable

I navigate proficiently through the menus in my RM software to find the features I wish to use.

- ○ Strongly Agree
- ○ Agree
- ○ Somewhat Agree
- ○ Neither Agree or Disagree
- ○ Somewhat Disagree
- ○ Disagree
- ○ Strongly Disagree
- ○ Not Applicable

I use the annotating and notes section of my RM software in order to keep myself organized.

- Strongly Agree
- Agree
- Somewhat Agree
- Neither Agree or Disagree
- Somewhat Disagree
- Disagree
- Strongly Disagree
- Not Applicable

I use RM software to generate a reference list or bibliography.

- Always
- Almost Always
- Often
- Sometimes
- Infrequently
- Almost Never
- Never

I use RM software to organize (or sort) references.

- Always
- Almost Always
- Often
- Sometimes
- Infrequently
- Almost Never
- Never

As part of my organizing references I create folders in the RM software.

- Strongly Agree
- Agree
- Somewhat Agree
- Neither Agree or Disagree
- Somewhat Disagree
- Disagree

- ○ Strongly Disagree
- ○ Not Applicable

I use RM software to share references electronically with colleagues.

- ○ Always
- ○ Almost Always
- ○ Often
- ○ Sometimes
- ○ Infrequently
- ○ Almost Never
- ○ Never

When we co-author we ensure that all the authors use the same RM software in order to share and migrate resources to each other.

- ○ Strongly Agree
- ○ Agree
- ○ Somewhat Agree
- ○ Neither Agree or Disagree
- ○ Somewhat Disagree
- ○ Disagree
- ○ Strongly Disagree
- ○ Not Applicable

I customize RM software to integrate with a word processing program to meet specific needs of colleagues or the task.

- ○ Always
- ○ Almost Always
- ○ Often
- ○ Sometimes
- ○ Infrequently
- ○ Almost Never
- ○ Never

Please rank in order the following features of RM software in terms of perceived complexity. For example, the 6th most complex would be the simplest feature or least complex.

	most complex	2nd most complex	3rd most complex	4th most complex	5th most complex	6th most complex (simplest)

store and track references	○	○	○	○	○	○
sort and organize references	○	○	○	○	○	○
generate a reference list or bibliography	○	○	○	○	○	○
sharing references electronically	○	○	○	○	○	○
making and annotating notes	○	○	○	○	○	○
integration with a word processing program	○	○	○	○	○	○

For the questions below, please check the answer that best fits your perceptions.
My knowledge of computers is sufficient for performing the functions required within the RM software.

○ Strongly Agree
○ Agree
○ Somewhat Agree
○ Neither Agree or Disagree
○ Somewhat Disagree
○ Disagree
○ Strongly Disagree
○ Not Applicable

I use my RM software seamlessly throughout my academic writing process by integrating its uses at all stages from draft through to final edits.

○ Strongly Agree
○ Agree
○ Somewhat Agree
○ Neither Agree or Disagree

- ○ Somewhat Disagree
- ○ Disagree
- ○ Strongly Disagree
- ○ Not Applicable

I need others to assist me to perform functions within the RM software.

- ○ Always
- ○ Almost Always
- ○ Often
- ○ Sometimes
- ○ Infrequently
- ○ Almost Never
- ○ Never

Indicate up to three things that you like about RM software

Indicate up to three things that you dislike about RM software.

Do you have any comments in general that you would like to share about RM software?

What is the primary reason you do not use RM software?

<Non-RM user continues here>

Are you currently a student?

- ○ Yes
- ○ No

Which level of degree are you undertaking? (only shown if they state they are a student)

- ○ Masters
- ○ Doctorate
- ○ Other (specify) ____________________

Are you currently a faculty member?

- ○ Yes

○ No

What academic rank of faculty are you? (only shown if they state they are faculty)

○ full professor
○ associate professor
○ assistant professor
○ adjunct or sessional lecturer
○ Other (specify) ____________________

How many research projects or articles are you currently working on?

[ ]

Have you published in a journal?

○ Yes
○ No

How many journal articles have you published in the last 7 years?

○ None
○ 1 to 3
○ 4 to 7
○ 8 to 12
○ 13 to 20
○ 21 or more
○ Not Sure

What is your age?

○ 25 or younger
○ 26-30
○ 31-35
○ 36-40
○ 41-45
○ 46-50
○ 51-55
○ 56-60
○ 61-65
○ 66 or older

What is your gender?

- ○ Female
- ○ Male

Thank you for participating in this study. You have now completed the survey. Please email me (richardrush@telus.net) if you are interested in participating in a follow-up interview on this research topic. The interview can be done by phone or email and would last about 30 minutes.

Appendix B3.4: Qualitative semi-structured interview questions

1. Please describe your general inclination to adopt, or not adopt a new technology?
    a. What factors influence your decision to adopt?
    b. What factors influence when you adopt, if you do?
2. Please describe your use of reference management software?
    a. What features do you use the most?
        i. How do you decide which features to use?
        ii. How frequently do you use each feature?
    b. Please describe which features and functions are most complex? Least complex?
        i. How do you define the complexity of a feature?
    c. What are the different ways you have integrated your use of reference management software?

Appendix B4: Sample size calculations

This study treated the population as an infinite population since in Canada more than 100,000 students enrol in Masters and Doctoral programs at over 40 universities across Canada each year (Elgar, 2001). Statistics Canada reports that number to be over 165,000 graduate students at over 70 institutions as of 2008 (http://www.statcan.gc.ca/pub/81-599-x/81-599-x2009003-eng.htm). AUCC, which is the Association of Universities and Colleges Canada, reports 42,000 full time faculty professors as of April 2015 (http://www.aucc.ca/canadian-universities/facts-and-stats/). The Canadian National Occupational Classification (NOC) website (http://www5.hrsdc.gc.ca/NOC/English/NOC/2011/Welcome.aspx) states that about 40,000 professors are currently employed in Canada.

Expected count conditions for required cross-tabulation analysis

Variables being used in the cross-tabulation should produce no cells with expected counts of zero, and no more than 20% of the cells with an expected count of less than five as commonly accepted requirements to use a Chi-Square analysis (Hair, et al., 2006). If these occur however, the variables should be recoded to larger groups to allow cells to meet these conditions (Cooper & Schindler, 2011).

Sample size for required PCA analysis

This study uses the guidance from Field (2005), Nunnally (1978, p. 421), Gorusch (1983), Hatcher (1994), Aleamoni (1976), Osborne & Costello (2004) and Comfrey & Lee (1992) for suitable sample size to perform a PCA. Based on absolute sample size 300 cases is considered good and the subject to item ratio used in the PCA is recommended to be greater than 5:1, preferably greater than 10:1.

Summary

In conclusion, with respect to sample size, a sample greater than 300 is desired. Furthermore, the target population is well above a 30,000 threshold so it can be treated as an infinite population with respect to a sample size of 300 (Cooper & Schindler, 2011). Note that a contingency measure to increase the number of respondents if not enough respondents were obtained, was to extend the survey to users outside of Canada, however, this was not necessary.

Appendix B5: Summary of invitations to participate sent

Sample Components	Number of requests sent	Time Sent
Faculty Associations	59	Early December 2015
Dean's Assistant in Graduate Studies Faculties	37	Early December, 2015
University Librarians	59	Early December, 2015
Graduate Student Associations	50	Early December, 2015
Program Coordinators – first wave	324	Mid-December, 2015
Program Coordinators – second wave	556	Mid-January, 2015
Program Coordinators – third wave	410	Late January, 2015

Appendix C – Pilot Study Results

Appendix C1: Pilot study demographics

Characteristic	Result
Sample size	26
Age	6 answered between 36 and 45, 13 between 46 and 55, and 7 over 56
Gender	19 female and 7 male
Hours per week on a personal computing device	3 responded between 11 and 20 6 between 21 and 30 17 over 31
Number of different types of academic software	4 use 3 or less 16 use between 4 and 7 4 use more than 8
Published in a journal	15 yes, 11 no
Do you regularly use a RM software	13 yes, 12 no, and 1 not sure
Which RM tool do you use	3 Endnote 3 Google 8 Mendeley 7 RefWorks 1 Zotero 4 Other
How many years have you used RM software (19 respondents)	Mean 3.95 years Range is 1 to 12 years
How many years have you been using a computer	Mean 28.62 years Range is 20 to 44 years
How many research articles are you currently working on	Mean is 2.56 Range is 0 to 10

Appendix C2: Principal Component Analysis on BRT and IDT items

Appendix C2.1: Total variance explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.763	39.052	39.052	9.763	39.052	39.052	6.272	25.088	25.088
2	3.482	13.929	52.981	3.482	13.929	52.981	3.965	15.859	40.947
3	2.798	11.192	64.174	2.798	11.192	64.174	3.848	15.393	56.340
4	2.079	8.317	72.490	2.079	8.317	72.490	2.559	10.238	66.578
5	1.547	6.187	78.677	1.547	6.187	78.677	2.237	8.947	75.525
6	1.389	5.558	84.235	1.389	5.558	84.235	2.177	8.710	84.235
7	.982	3.927	88.162						
8	.883	3.533	91.695						
9	.537	2.147	93.842						
10	.461	1.844	95.685						
11	.361	1.444	97.129						
12	.258	1.032	98.162						
13	.191	.764	98.926						
14	.136	.545	99.470						
15	.073	.293	99.764						
16	.042	.167	99.930						
17	.017	.070	100.000						
18	4.7E-16	1.8E-15	100.000						
19	2.3E-16	9.3E-16	100.000						
20	1.1E-16	4.5E-16	100.000						
21	-4.4E-18	-1.7E-17	100.000						
22	-1.5E-16	-6.0E-16	100.000						
23	-2.5E-16	-1.0E-15	100.000						
24	-4.2E-16	-1.7E-15	100.000						
25	-5.2E-16	-2.1E-15	100.000						

Extraction Method: Principal Component Analysis.

Appendix C2.2: Rotated component matrix

Item	Component 1	2	3	4	5	6
B1ThemainreasonIuseRMsoftwareistokeeptrackoftheart	.608					
B2IcanexplainthefeaturesofmyRMsoftwaretoothers	.768					
B3InavigateproficientlythroughthemenusinmyRMsoftwa	.753					
B4DoyouuseyourRMsoftwaretosharereferenceselectronicall				.724		
B5DoyouuseyourRMsoftwaretogenerateareferencelistorb		.882				
B6DoyouuseyourRMsoftwaretoorganizesortreferences		.802				
B7IusetheannotatingandnotessectionofmyRMsoftwareino	.913					
B8IusetheRMsoftwaretoselectthebestreferencesandartic						
B9WhenIcoauthorweensurethatalltheauthorsusethesame				.747		
B11IusemyRMsoftwaretoenterinmyreferencesasIfindthe	.637					
B12AspartofmyacademicwritingIcreatefoldersintheRMso		.722				
B13IusemyRMsoftwareseamlesslythroughoutmyacademicwriti	.901					
A12Myknowledgeofcomputerswasenoughforperformingthefunction	.671					
A1Iliketotrynewtechnologiesjusttoseeiftheywork				.601		
A2Iamcomfortablewithusingandunderstandingtechnicaljargo						
A3Ihavehighexpectationsfornewtechnologies			.813			
A4Ilookatthetechnologyforwhatitcandofromaworkpersp			.767			
A5Iam4askedforadviceontechnology						.615
A6Productqualityisimportantinthedecisiontouseorrecomm			.883			
A7IlooktootherpeoplewhoseopinionsIrespectforrecommend						
A8Thecostsofhightechproductsarenotworththemoneyinves		.825				
A9Theavailabilityofsupportservicesisimportantinthedeci					.938	
A10Ihaveafearofhightechnologyproducts						.646
A11Ibelievemostnewtechnologywillfail						.839
B10IcanexplaintootherstheStepsforthemainfeaturesofR	.839					

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization

Appendix C2.3: Reliability values for components

Component	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
1	.932	.934	8
2	.853	.857	4
3	.730	.745	3
4	.690	.675	3
6	.751	.772	3

Appendix C3: Feature complexity ranking

Feature	N	Minimum	Maximum	Mean	Std. Deviation
Organize references	20	1	5	2.85	1.27
Sharing references electronically	20	1	6	3.00	1.95
Making and storing notes	20	1	6	3.05	1.70
Integration with a word processing program	20	1	6	3.15	1.57
Creating a bibliography	20	1	6	4.00	1.49
Store references	20	2	6	4.95	1.40

Appendix D – Main Quantitative Study Results

Appendix D1.1: Demographic Statistics Comparison

Characteristic	All 398 cases	311 cases of RM users
Male / Female Split	67% Female / 31% Male	67% Female / 31% Male
Student / Faculty Split	79% Student / 18 % Faculty	77% Student / 20 % Faculty
Doctorate / Masters Students	51% Doctorate / 50% Masters	51% Doctorate / 46% Masters
Published in last seven years	54% Yes	56% Yes

Note: Comparing all 398 cases with only the cases that use RM software

Appendix D1.2: Descriptive Statistics Comparison

	All 398 cases		311 cases of RM users	
	Mean	Std. Deviation	Mean	Std. Deviation
Computer use (years)	20.44	6.86	20.75	6.92
Number of current research articles	3.28	4.63	3.36	4.99
RM software use (years)	4.60	4.40	4.75	4.41

Note: Comparing all 398 cases with only the cases that use RM software

Appendix D2: PCA on BRT and IDT items - Total variance explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.292	24.056	24.056	5.292	24.056	24.056
2	2.728	12.398	36.455	2.728	12.398	36.455
3	1.565	7.112	43.566	1.565	7.112	43.566
4	1.39	6.316	49.883	1.39	6.316	49.883
5	1.308	5.946	55.828	1.308	5.946	55.828
6	1.252	5.69	61.519	1.252	5.69	61.519
7	0.937	4.258	65.776			
8	0.928	4.217	69.993			
9	0.854	3.882	73.875			
10	0.745	3.385	77.259			
11	0.719	3.269	80.528			
12	0.632	2.875	83.403			
13	0.585	2.66	86.063			
14	0.549	2.496	88.559			
15	0.503	2.286	90.846			
16	0.485	2.204	93.049			
17	0.373	1.697	94.746			
18	0.351	1.594	96.34			
19	0.273	1.243	97.582			
20	0.219	0.996	98.578			
21	0.174	0.793	99.371			
22	0.138	0.629	100			

Appendix D3: Reliability statistics on components

Appendix D3.1: Component 1 (BRT Low Order) reliability

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.857	.865	7

Appendix D3.2: Component 2 (Innovativeness) reliability

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.820	.820	4

Appendix D3.3: Component 3 (BRT High Order Mastery) reliability

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.601	.608	3

Appendix D3.4: Component 4 (Support reliance) reliability

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.473	..479	3

Appendix D3.5: Component 5 (Product quality and reference reliance) reliability

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.239	.250	2

Appendix D3.6: Component 6 (Personal technology expectations) reliability

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.512	.514	2

Appendix E – Copy of Athabasca University Research Ethics Board Approval

June 10, 2014

Mr. Richard Rush
Faculty of Business\Centre for Innovative Management (MBA & DBA)
Athabasca University

File No: 21487

Certification Category: Human Ethics

Expiry Date: June 9, 2015

Dear Mr. Richard Rush,

The Athabasca University Research Ethics Board (AUREB) has reviewed your application entitled 'Connecting the Dots - Using Learning Taxonomy to Enhance Understanding of Innovation Adoption'.

Your application has been **approved** and this memorandum constitutes a ***Certification of Ethics Approval***. You may begin the proposed research. Collegial comments for your consideration are offered below:

You submitted a well presented REB application. The research took good care of addressing important ethical considerations for the whole data collection process and archiving. I had one concern about using an online survey, even Canadian: some of the features offered, such as "sharing the survey on Facebook, or via website pop-ups, may result in privacy concerns to participants. [There are different identification and privacy concerns involved in the design of the survey. The researcher should be sure ahead of time how the survey will be designed and administered, so that the permission structure accurately reflects the participant choices that will be available.]

AUREB approval, dated June 10, 2014, is valid for one year less a day.

As you progress with the research, all requests for changes or modifications, renewals and serious adverse event reports must be reported to the Athabasca University Research Ethics Board via the Research Portal.

To continue your proposed research beyond June 9, 2015, you must submit an Interim Report before May 15, 2015.

If your research ends before June 9, 2015, you must submit a Final Report to close our REB approval monitoring efforts.

At any time, you can login to the Research Portal to monitor the workflow status of your application.

If you encounter any issues when working in the Research Portal, please contact the system administrator at research_portal@athabascau.ca.

If you have any questions about the REB review & approval process, please contact the AUREB Office at (780) 675-6718 or rebsec@athabascau.ca.

Sincerely,

Fathi Elloumi,
Chair, Faculty of Business Departmental Research Ethics Committee
Research Ethics Board