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DETERMINANTS OF ANALYTICS ADOPTION IN K-12 ORGANISATIONS

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Dedication

I dedicate this dissertation to my family which stood by me in times of doubt and never failed to offer their encouragement during this journey of learning and discovery.

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Abstract

In times of increasing calls for controlling public spending, evidence-based decision making and capabilities in data analysis informing organisational choices align well with improving efficiency. However, technology adoption needs a strategy as part of the conditions for analytics to gain a lasting foothold in organisations. Short-term considerations and a search for expediency can take precedence over the implementation complexities and efforts to gain knowledge in the proficient use of solutions.

This research investigates the adoption of analytics in the publicly-funded education system of the province of Ontario in Canada. The relationship between themes of strategy, adoption, and analytics is explored from the perspective of Ontario school districts leaders in education. While previous research in the Ontario K-12 setting involved usage of technology in the classroom, this study extends the exploration of analytics adoption to an organisational setting. Data collection consisted of questionnaires and surveys based on two case studies conducted in different school districts. External evidence and observations were used to complement the empirical data.

A total of six hypotheses were developed from the research questions and tested. All hypotheses were rejected on the basis of their *t* Statistic, except one complying with the theory. A modified UTAUT model remained consistent with the theory in its results and took into account the assumptions of this study. However, an unexpected result was the strength of effort expectancy having twice the impact of either performance expectancy and social influence on behavioural intention. Facilitating conditions with the moderating effects of age, gender, experience, and willingness to use were not found to

be significant. Contradicting interviewees who judged the issue relevant, school enrolment size was also not statistically significant in the inferential analysis results.

The results of the study suggest that strategy is central to the adoption of analytics. To assist adoption, the strategy should insist on extensive consultation with end-users and training by data professionals. The study also challenges the applicability of the basic UTAUT model for adoption of analytics in school districts by proposing an alternative model appropriate for school districts and the exploration of the topic and the themes.

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Chapter I - INTRODUCTION

General Introduction

Analytics, or the extensive and systematic analysis of data, may offer transformative data-driven outcomes for K-12 organisations, according to Siemens and Baker (2012). For example, analytics has been used to evaluate the learning and progress of students (West, 2012).

The adoption and use of analytics capabilities in Ontario, however, are not widespread. Despite financial assistance from the Ontario Ministry of Education to develop school districts' data systems capacity to feed a provincial data warehouse (Dunn, Jaafar, Earl, & Katz, 2013), use and integration of analytics among Ontario district school boards for predictive or prescriptive purposes varies greatly (C. Campbell & Levin, 2009).

Regardless of their size or stakeholders' expectations, some districts have never pursued an analytics initiative of their own, while others have transitioned to a post-adoption stage, and others still have discontinued use of an existing solution (Crompton & Keane, 2012; Pichette, Boisvert, Monteith, & Kappel, 2013). In those transitioned districts, analytics is leveraged to facilitate their operations, as well as to contribute to their students' academic and personal success (West, 2012). Starting from the identification of the problems with adoption of analytics, a mitigation approach which identifies the challenges and difficulties encountered by districts embarking in a future analytics initiative may enable school districts within Ontario to move forward to complete a transition to analytics (Rogers, 2000).

Statement of Problem

Despite a concerted *Managing Information for Student Achievement* (MISA) initiative, and assistance provided by the Ontario Ministry of Education (C. Campbell & Levin, 2009; Dunn et al., 2013), a number of Ontario district school boards have not developed a true data warehouse to support management decision making (Ramamurthy, Sen, & Sinha, 2008). Although specific adoption figures of analytics use in Ontario education are not available, Swoyer (2013) reported an estimated adoption rate of only 25 percent across the economy worldwide.

The challenge may be that some district school boards lack a strategy to exploit analytics. Also, some district school board officials may have little knowledge on how to facilitate the adoption of a strategy on analytics within a district school board environment. However, no known research has specifically explored these challenges in the context of Canadian school boards.

Purpose of the Study

The purpose of this study is to determine factors which contribute to analytics adoption and use in K-12 organisations. The study will explore what knowledge is required to facilitate the adoption of a strategy on analytics within a district school board environment. The target population for this study is comprised of district school board superintendents and senior administrators in Ontario. The chosen population is purposely appropriate for the study, as school district superintendents and senior administrators can provide a multi-data perspective, at the business and pedagogical levels, regarding the strategy to adapt, implement and exploit data through analytics as a part of the decision-making process.

The study aims to contribute to an understanding of what constitutes a suitable environment where analytics will be adopted in a school board (Buabeng-Andoh Charles, 2012; Park, Gunn, Lee, & Shim, 2015; Rauscher, Casteel, & Bush, 2015).

Research Questions

The complexity of introducing innovations in education is known to demand a strategy to help cope with resulting changes in the practices of educators (Somekh, 2008). This strategy was meant to pave the way for the introduction of changes brought by the innovation and improve user acceptance of that innovation. Venkatesh, Morris, Davis, and Davis (2003) saw acceptance and use of innovative technology by workers as a source of increased efficiency in the organisation, leading to adoption of the innovation.

In instances where organisations considered the adoption of analytics, Davenport (2006) viewed the formulation of strategies as an essential and consequent initial investment. This study explored the relevance of strategy for school boards.

The relevance of organisational slack as a necessary driver for innovation was proposed by Herold, Jayaraman, and Narayanaswamy (Herold, Jayaraman, & Narayanaswamy, 2006). Successful adoption of analytics depended on organisational slack allowing the allocation of necessary financial and human resources to the initiative. Therefore, this study considered strategy, adoption and student enrolment in school boards. Finally, the funding formula of Ontario school districts, based in part on a per pupil basis, suggested more human and financial resources to launch an analytics initiative might exist in larger districts (X. Li, 2015).

The key research question for this study was:

1. What are the key determinants of analytics adoption in Ontario K-12 district school boards? Three peripheral questions emerge from this key research question that the study aims to also answer.: These include:
    i. To what extent is a strategy necessary for the adoption of analytics by these school boards?
    ii. What strategies have been used for analytics adoption?
    iii. To what extent does the size of a school board and student enrolment influence analytics adoption?

Key determinants of analytics adoption in K-12 organisations. The indicators of school system success constitute a well-researched subject. There are measures of outcomes at a provincial level derived from a number of sources (Hauseman, 2015). Local assessments done within a school district or standardised tests conducted by the Education Quality and Accountability Office (EQAO, 2013) provide data at the meso-level of a single district.

The EQAO polling revealed that 96 percent of school principals used results on student performance to guide school improvement initiatives in the areas of reading, writing and mathematics. The literature proposed actions susceptible to assist with the academic success of students at risk (Finn, 1997). Finn presented analytics, when placed in the hands of professionals able to use the information, as an effective tool for making a positive impact on student achievement.by efficient and early identification of students who were underperforming academically.

A number of theories on technology adoption have been proposed since early efforts by Tarde at the turn of the 20th century., and the subject gained in recognition

through the seminal work of Rogers, sixty years later (Lechman, 2013). In this study, understanding the key determinants of analytics adoption in Ontario K-12 district school boards was done through the lens of a framework intended for decision-makers interested in evaluating the likelihood of success in bringing innovations to the organisation (Venkatesh et al., 2003).

Need for a strategy in adoption. This study viewed strategy as a question of plan, pattern, position and perspective. Mintzberg (1987a) offered five possible definitions of strategy as plan, ploy, pattern, position, or perspective. These views are still referenced in recent studies (Mendes, 2018). The definitions are not mutually exclusive, do not represent a chronological progression and interrelationships exist between the definitions. The sole certainty on the pertinence of the chosen strategy resided in assessing the realised strategy after the fact. Ploy as a strategy was considered less likely in a setting highly regulated by the Ontario Ministry of Education. School district senior leaders participating in this study shared a possible *plan* as a strategy around analytics. This regulatory background spoke to a discernable *pattern* of behaviours in strategizing.

Although school districts serving different geographical areas are not in competition, coterminous school boards that share a geographical area have cause to compare their services and ensure they offer comparable or better services than the immediate neighbours as part of their *position* in the external environment. Although set in a higher learning context, Baer and Duin (2014) suggested the sanction for not adapting to changing conditions could otherwise be to lose funding when students transfer to another school district. In similar fashion, the internal environment will shape their *perspective* on the intended strategy considered the most appropriate.

However, Mintzberg (1987b) took exception to the view commonly held that strategy was an absolute requirement for organisations. There are instances, he argued, when organisations must be free to respond quickly to changing conditions and when a set strategy could enforce a rigidity in behaviour when a large degree of flexibility would instead be called for. This research witnessed divergent views from respondents on the subject of the relevance of strategy in analytics adoption.

Adoption. The resources necessary for the adoption of an innovation are proportional to the complexity of the innovation (E. M. Rogers, 2003). In reference to work done separately by Swanson (1994) and Fichman (1992), Ramamurthy et al. (2008) described two typologies of information technologies and adoption of innovations. Under the definitions proposed by either typology, analytics belonged in the highest tier. Swanson's Type 3 IT technology corresponded to an innovation aimed at integrating core functions of the host's organisation, whereas Type 2 limited its focus to administrative processes (Swanson, 1994). In the two-tier typology defined by Fichman (1992), applications of technology intended to support many interdependent users were considered Type 2 technologies. Type 1 technologies, in that same typology, affected users working in isolation. The implementation of analytics envisioned by educators was clearly not restricted to administrative processes, nor intended for a single-user. This classification under Fichman's Type 2 was confirmed in the case of the adoption of business intelligence by other authors (Muhammad, Khan, Amin, & Lambrou, 2010). Therefore, adoption of analytics can be considered as requiring a significant effort on the part of many members of the organisational system, thus constituting a potential factor in the adoption of analytics.

The task-technology fit (TTF) of analytics to school districts is another potential driver of adoption. TTF fit was defined by Kuo and Lee (2011) as the level of congruence between the capabilities of a new approach and existing processes imposed to accomplish a task. Establishing if that congruency existed in justifying the needed effort by individuals is evaluated as part of this study.

The shift in culture fit from the innovation would also affect people reaching the end of their career more than those starting out (Blackburn & Blackburn, 2011; Popovič, Hackney, Coelho, & Jaklič, 2012). Consequently, factors such as age and level in the hierarchy were considered relevant as well in the literature (Venkatesh et al., 2003).

In summary, the factors of 1) amount of effort expended; 2) task-technology fit; 3) age; and 4) career stage should all be investigated in terms of their contribution to analytics adoption.

Enrolment size. The complex relationship between the size of a school board and student performance was examined by Leach, Payne, and Chan (2010). The expected economic benefits of a larger student enrolment size were stated objectives of the 1998 round of board consolidations (Maclellan, 2007). The gains would follow a logic of economies of scale and scope, whereby larger contracts at lower prices could be negotiated and a larger workforce could increase flexibility. In addition, new facilities for a single purpose would become financially feasible in a large organisational structure. However, the evidence brought by research was less compelling. A study conducted by Duncombe, Miner, and Ruggiero (1995) found diseconomies of scale in boards over 5,000 students. Despite some concerns over the suitability of some of the data used, Leach et al. (2010) reported a number of studies showed that school size, district

enrolment and the number of high schools had a negative correlation with student performance. (Leach et al., 2010)

A specific negative effect of size on student performance reported by Troshani, Rampersad, and Plewa (2011) concerned the difficulty of maintaining a standard approach in IT adoption as the size of an organisation increased. Organisational fit suffered from size, with workers having increasing disparities in knowledge and interest.

Enrolment size, and its corollary of greater financial capacity grants calculated on a per student basis, would impact organisational slack as discussed above. Herold et al. (2006) tied organisational slack to innovation, demonstrating that resources, while not a guarantee of success, had a demonstrable role in facilitating innovation.

Therefore, and in contradiction with research arguing organisational size was not a reliable factor in adoption, other studies saw a role for size, (Dougherty & Hardy, 1996; Forés & Camisón, 2016; Kademeteme, Kalema, & Pretorius, 2017; Mahesh, Vijayapala, & Dasanayaka, 2018). Therefore, enrollment size will be examined in this study.

Significance of the Study

Analytics may assist the budgeting decision making process in education (Picciano, 2012). Government policy makers within Ontario face the challenge of utilizing public funds to deliver programming in an efficient and effective manner while demonstrating fiscal prudence of the public purse (Bowles & Bosworth, 2002). To reach expected results in teaching efficacy, Kotsiantis (2012) posited educators might benefit from the availability of capabilities in data analysis that enabled the identification of students who are struggling at the elementary and secondary level. Limited resources, what Rogers (2003) referred to as the hardware or the physical tool, as well as the

software which is the information base for the tool, can be obstacles to acquiring capabilities considered as beneficial to the academic success of students.

The trend in public spending on education with the aim of improving quality and accessibility of the delivery of services has been a continuous upward incline. The acquisition of requisite tools explained in part the pace of growth in expenditures in the education sector within most of the Organisation for Economic Co-operation and Development (OECD) countries (Hauptman, 2015) greater than the growth rate of their Gross Domestic Product (GDP). In 2007-2008, financial resources directed to educational institutions averaged 6.1% of the combined GDP for the 36 OECD member-states (Statistics Canada [SC], 2011). In fact, almost two-third of those funds (61%) were devoted to primary, secondary and post-secondary non-tertiary education, excluding kindergarten and any college or university spending from that percentage; which translated to approximately 3.7% of combined GDP or $US 1.5 trillion on $US 41 trillion of the total GDP in 2008 for OECD countries (OECD, 2015).

Despite this general upward trend in funding education, prior to the 2008 global economic downturn and in contrast to past protection afforded to its education sector (Jefferson, 2010), the province of Ontario has signalled its intent to control increases for elementary and secondary publicly-funded education (Government of Ontario, 2015). Estimates prepared for the 2015-16 provincial budget called for a small decrease of 0.36% or almost $90 million, compared to the 2014-15 estimates in Ministry of Education total operating expenses of close to $25 billion. Therefore, school districts may hesitate to launch any imitative, such as analytics, that requires a long implementation period before the desired results become visible and obvious.

In addition, the Ontario Ministry of Education's requirements for research data were addressed when it created the Ontario Student Information System (OnSIS) (Dunn et al., 2013). This large repository of "comprehensive data on each student and teacher in the province" (Dunn et al., 2013) was updated by different district school boards under penalty of reduced funding for untimely or non-compliance of OnSIS data submissions. OnSIS staffs assisted the government in making budget decisions and establishing the provincial improvement strategy. The intent, clearly stated, was to restrict access into OnSIS to Ministry staff or duly mandated researchers (Dunn et al., 2013).

Although not mandated, school boards were expected to build their own data warehouses. Assistance was provided by the Ministry in the form of funding and regional Managing Information for Student Achievement (MISA) / Professional Network Centres (PNC) meetings of Ministry and school board staff. In following this strategy, boards obtained (Dunn et al., 2013) both the financial means to acquire the technology (hardware) and some of the knowledge (software) to use that technology, thus obtaining the opportunity to adopt analytics. In other words, every school board in the Province of Ontario possessed requisite resources to adopt analytics, if they deemed this to be important.

Despite the availability of the financial resources needed to adopt analytics and as shown by the two districts under study, efforts deployed by individual school districts have been insufficient to reach parity among boards in the potential benefits derived from analytics. However, Dunn et al. (2013) identified the York Region District School Board as an example of an effective introduction of capabilities based on analytics in an Ontario

School Board to improve the identification of, as well as the response to, the needs of students and teachers.

Considering the significant resources committed by the Government of Ontario, near or outright failures to see analytics adopted in a district school board are not discussed in public forums by school districts. Although set in the context of higher education, Guster and Brown (2012) offered a more sobering view of limitations preventing an analytics system from reaching its full potential. These limitations, tied to political and control issues, served as a cautionary note against excessive expectations placed upon an analytics system. Jiang (2009) suggested trusted contacts, known as referent groups, guided by word-of-mouth potential adopters of analytics in the decision-making process, were a key factor in decisions to embark or cease the deployment of an analytics solution. Thus, lessons of the past impacted the decision-making process of adoption itself. A better understanding of why some implementation of analytics succeeded and others remained weak is essential in order for future adopters to avoid failure. Such an approach would require work upstream during the adoption process, to determine if the presence of a given set of ideal conditions in a district school board might make a measurable difference in predicted success or failure for an analytics solution.

In the remainder of this research, Chapter 2 will cover a review of the literature relative to the topic of analytics adoption, while Chapter 3 will present the proposed methodology to be used in the research. The analysis of data collected will be conducted in Chapter 4. Chapter 5 will conclude and close the study.

Chapter II - LITERATURE REVIEW

This literature review will explore the K – 12 organisational environment, as well as various theories used to relate K-12 education institutions to the adoption of analytics by these institutions. The literature review will consider academic literature and management books on the subject to offer "a comprehensive overview of prior research regarding a specific topic" (Denney & Tewksbury, 2013, p. 218). The chapter is separated into three major sections. The first section is devoted to the K-12 landscape; the second section to how the landscape impacts strategy, adoption, and analytics; and, the last section presents theoretical work suitable to gain an understanding of the adoption of analytics by Ontario school districts.

K-12 Landscape

The K-12 landscape presents some unique characteristics that may influence how analytics are viewed. An understanding of the K-12 education system in Ontario relative to the way district school boards operate, make decisions and allocate resources is contextually necessary. Key facets of this landscape that may impact this study by their effect on perceptions of analytics and decision-making regarding adoption in the education system are discussed as follows.

Education. According to Kimmons (2015), "the disparate nature of K-12 education and the autonomy of institutions" (p.379) serve as key differentiators from higher education. A brief overview of the characteristics of K-12 education in Ontario nuances this assertion, demonstrating how a boilerplate organisational structure may lead to varying individual decisions.

Education in Ontario is adjusting to 20 years of administrative reforms in the governance of school districts categorised in one of four distinct groups of publicly-funded primary and secondary education namely, English Public (i.e., not Catholic), English Catholic, French Public, and French Catholic (Galway & Wiens, 2013; Sattler, 2012). The Canada-wide compulsory school attendance requirement of 16 years of age was raised in Ontario in 2005, and resulted in creating the requirement that one of two conditions must be satisfied by the student: either 18 years of age or high school graduation (Dunn et al., 2013). This extension to the Canada-wide requirement for school attendance for some students included measures to assist each student along a learning journey adapted to individual needs (C. Campbell & Levin, 2009; Winton, 2013). Guster and Brown (2012) worried that, as each university operates individually, analytics in higher learning would have different applications. While Ontario K-12 education is aligned on regulations, school districts retain a level of autonomy as discussed in this text. Therefore, applications of analytics in Ontario school districts can also take different paths.

Another feature of Ontario K-12 education was the place taken by the publicly funded system, fully bound by provincial regulations in return for provincial resources (Lupart & Webber, 2012; McKay, Byers, Voyer, Humphreys, & Markham, 2014). Unlike the significant body of literature on higher learning where van Barneveld, Arnold and Campbell (2012) saw a need for a common language to discuss analytics, Ontario school districts share the same vocabulary on all subjects with policy memorandums (Ontario Ministry of Education, 2016) and other documents, including on analytics. Enrolment figures indicated ninety-five percent of young Ontarians attended the public education

system (Leonard, 2015). Private schools catered to 4.1% of students, followed by federal and first-nations schools (0.7%). In order to reduce confusion on vocabulary, external support, and internal capabilities, this study will focus solely on the publicly-funded school system.

The slow pace of change in Ontario school boards is evident in the fact that organisational and operational structures have remained largely unchanged in over a century (Galway & Wiens, 2013; Li, 2015; Robertson, 2014). For example, the transformation of school boards at the beginning of 1998 into district school boards resulted from the 1993 appointments of the Royal Commission on Learning and the Ontario School Board Reduction Task Force in February 1995. The Ontario provincial government, elected in 1995, continued and expanded an agenda to reduce funds spent on bureaucracy and administration through the consolidation of school boards into fewer, larger entities (Garcea, 2014). The Fewer School Boards Act (Bill 104) prescribed which school boards would amalgamate together into district school boards (Hannay, Jaafar, & Earl, 2013). This process of school board amalgamation for organisations, imposed by the province, created the 72 district school boards in existence today (Sattler, 2012). In that context of stability, the significance of studying the introduction of analytics, a potential disruptive technology (Schlesinger & Rahman, 2015) gains new relevance.

Reid (2014) compiled statistics for the 60 English public or Catholic school districts and reported a total enrolment at the elementary and secondary levels approaching 2 million students for the 2009-10 school year with a further 92,976 student in 12 French boards. Guarantees entrenched in the Canadian Charter of Rights and Freedoms of 1985 regarding representative governance, were in place everywhere in

Ontario in the form of school boards (Li, 2015). Therefore, the organisational focus, as well as the unit of analysis used in this research, requires further discussion of the concept of Ontario district school boards, as presented in the next sub-section.

Ontario district school boards. Final responsibility for education rests with the provinces and territories in Canada under the terms of the *Constitution Act, 1982* (Pollock, 2013). However, school boards were not a product of the enactment of that key legislation, and the existence of many school boards in North America predated even the legal creation of the Canadian Confederation in 1867 (Li, 2015). School boards existed as organisations according to the *School Act* of 1816 to provide a local venue and organisational structures where democratically elected representatives of citizens could voice their opinion regarding the education of primary and secondary students (Sattler, 2012), while remaining accountable for the execution of their constituents' decisions (Mueller, 2011). Research confirmed the relevance of the goals assigned to school boards and of school boards themselves (Sheppard, Galway, & Brown, 2013). Financial and academic outcomes in the delivery of educational services have been tied to school boards. The positive impact of school boards is attributed to their ability to maintain trust with, and offer a common vision to, the local community. School boards offer a rampart against divisive forces, either external, from governmental decisions, or internal, while trying to observe progress in student learning at an organisational or individual school level.

Enforcement of provincial policies by school districts is verified at the provincial level. Hunter and Dolmage (2013) identified how, over a 30 year period ,failure to comply with provincial mandates across Canada resulted in the loss of self-governance

due to the appointment of a provincial supervisor. Additionally, despite the current pre-eminence of the provinces in education, all three levels of government remain involved in the delivery of education services in Canada to some degree (Sattler, 2012). For example, provincial governments supply legal, administrative and financial guidance for primary and secondary education, the federal government provides additional funding, local school trustee elections are held at the same time as municipal elections (Sattler, 2012), and school district elections represent a second form of accountability for school boards to the local public.

In 1998, the Ontario Ministry of Education gained control over the disbursement of all financial resources to school boards. The complex funding formula, determined after negotiations with stakeholders (Galway & Wiens, 2013; Sattler, 2012),which were described as controversial by Hunter and Dolmage (2013). For example, the search for a compromise solution translated into some interest groups gaining and others losing ground during each round. Prior to Bill 104, which reduced the number of school boards in Ontario, school boards would establish a taxation rate based on the property base of their system supporters (Galway & Wiens, 2013; Sheppard et al., 2013). Tax support would, by default, be directed to the local English non-denominational school board. Owners or residents would have to force redirection to Catholic or French boards, if they were allowed and wanted to. This system created large financial disparities between Ontario school boards, disparities that continue to affect the current generation of decision-makers (S. Robertson, 2014). As such, the level of financial resources allotted to school boards, and the individuals who make those decisions, affects the number of options available.

Decision makers. Accountability and responsibility for reaching goals in school districts are shared between governance and management (Codrington, 2014). Governance is entrusted to school trustees elected by the public and board committees, while management is entrusted to run daily operations.

In looking at critical points relevant to trustees, the Minister of Education delegates to school trustees the authority to oversee the day-to-day administration of school boards. Once sworn in, trustees may hire, or renew their confidence in, an individual for the position of Director of Education (Leadership Development Branch, 2011). In principle, trustees appoint and dismiss every employee in the district, while, in practice, the Director of Education is the head administrator and acts as an intermediary in communication between trustees and board employees. In fact, trustees seldom exercise their full legal authority in matters relating to finance, personnel and communications, leaving those issues to management (Hunter & Dolmage, 2013; Li, 2015; Sattler, 2012). Budgets prepared by management would be discussed and usually adopted with minor amendments. Proposals submitted by senior staff to modify educational programmes in the district were similarly examined by trustees and their acceptance was tied to public opinion and confidence shown in management's abilities.

The management teams of Ontario school districts are headed by Directors of Education as chief executive officers (Hunter & Dolmage, 2013) of their respective district school boards. Directors of Education surround themselves with a team of fellow executives, the Superintendents. Each superintendent is assigned a different portfolio of board-wide programmes. The number of senior administrators in each district is determined by the size of the enrolled student population and the administrative structure

adopted by the district. Directors of Education and Superintendents report to their immediate superior, their board of trustees. All members of the executive remain accountable regarding implementation of provincial education policies to the Ontario Ministry of Education which establishes standards of certification, appointment and dismissal of supervisory officers (Leadership Development Branch, 2011).

Board of Trustee meetings are held on a regular basis and follow a public agenda (Codrington, 2014; Hunter & Dolmage, 2013; Mueller, 2011). Superintendents are in attendance to present issues pertaining to the portfolio they hold and to answer questions. Stakeholders from the school community at large are also present except during portions when sensitive questions involving privacy are discussed (Hunter & Dolmage, 2013).

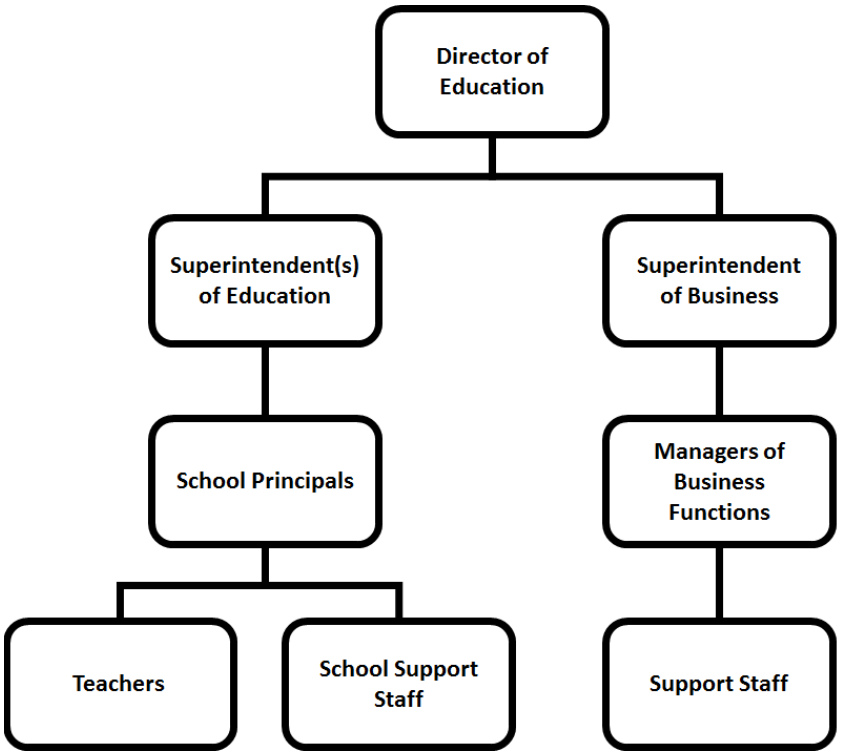

Figure 1. Reporting Structure in Ontario School Districts.

Schools and central administrative support functions divide into two branches in the management model of a district school board, below the level occupied by superintendents. The largest branch consists of principals supervising the teachers assigned to their school and committed to instructional leadership (Neumerski, 2013). High school teachers are organised within their own hierarchy with department heads (Abreu & Acker, 2013). However, principals, not department heads, sign off on the work performance of their teachers (Maharaj, 2014; Pinto et al., 2012).

In the second branch, consisting of support departments such as a human resources department or a maintenance department, a manager will occupy the role equivalent to a school principal (Winton & Pollock, 2013). Managers have greater discretionary spending powers than school principals, whose spending authority is limited to their own school. Unlike department heads in schools, another layer of supervisors is found in support departments, with the added responsibility for job performance evaluation of individuals reporting to them.

Resource dependence. The above description outlines a model of decision-making in district school boards. The model suggests a hierarchical top-down bureaucracy. However, a more apt analytical framework for Ontario district school boards may be offered by adopting a resource dependence perspective (Andrews & Johansen, 2012; Drees & Heugens, 2013; Pfeffer & Salancik, 1978). A resource dependence perspective considers how much organisations owe to their environment, in explaining their behaviour and level of success. In the context of the Ontario school board system, resource dependence assumes acceptance of two tenets. First, school boards are bound by external constraints due to regulations, neighbouring school boards

and a limited pool of potential students (Neely, 2015). Second, school boards, especially the Catholic and French systems, are active in responding to imposed limitations by engaging their community to mitigate external threats regarding their percentage share of students, and ultimately survival.

As discussed previously, funding is stipulated by the province, and only through differentiating the services offered can some boards manage to attract or retain students from other boards or private schools. Examples of differentiation appearing in literature are English boards offering a bilingual education (Croteau, 2014; Winton & Pollock, 2013) or boards proposing specific services to students with special needs (X. Li, 2015; Pollock, 2013; S. Robertson, 2014). To secure specialised funding, the Ottawa-Carleton District School Board maintains both a technical high school and a high school devoted to the arts (OCDSB, 2018). These two schools are unique among the four school districts serving the Ottawa region and students interested in these study programmes must attend these schools and that school district.

District decision making. As long as Ontario school districts abide by mandated rules, they retain considerable freedom in their decisions. One district might decide to adopt an innovation and another district may reject the same innovation. This autonomy of institutions in K-12 education was raised by Kimmons (2015) and would appear to be confirmed by his results pointing at the difficulty of confirming adoption, use and impact of innovation in elementary and secondary education.

In terms of analytics adoption, Scheffel, Drachsler, Stoyanov, and Specht (2014) suggest it may in fact be an obligation, rather than a choice for high functioning educational institutions:

> "the implementation of enhanced analytics is to be seen as critical for student success on the one hand, and achieving institutional effectiveness on the other, as, without it, organisations cannot meet the current gold standard for institutional leadership" (p.129).

In order to continue in that line of thought, the following section will examine how technology is perceived at top levels of school districts administration.

Perceptions of technology in learning. Perceptions constitute one source of internal obstacles to the adoption of technology by educators (Rogers, 2000). The other source of internal obstacles relates to a teacher's true ability in using the new technology. Both sources of internal obstacles are to be considered together, rather than separately to avoid the trap of pro-innovation bias. However, aside from innovators, early adopters and laggards, the majority of potential adopters will wait for practical benefits of the technology to become evident to them (Sang-Gun, Trimi, Kim, & Lee, 2013).

Sheppard and Brown (2014) reported that a majority of senior education leaders, participating in a study, held some doubt over the positive impact of emerging technologies on learning in a traditional or brick-and-mortar classroom setting. This view was echoed in Richardson, Beck, LaFrance, and McLeod (2016, p. 215) where distance learning principals considered "technology literacy […] at the core of [their] role". The perception of educators will therefore play an important role in determining their interest in new technology. To further illustrate the influence of perception on this study, the themes of strategy, adoption and analytics are reviewed.

Strategy, Adoption, and Analytics

District leaders in education, superintendents and school principals are teachers (Winton & Pollock, 2013). Although their role may no longer include teaching students, their instinctive reactions are to think as teachers. In similar fashion, experiences in the classroom continue to shape decisions made because district decisions invariably impact teachers. These facts continued to influence the review conducted around the three themes.

Strategy. In order to understand its role in organisational decision-making, a classic definition of strategy is helpful:

> "The determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals." (Chandler, 1962)

The relevance of strategy in adoption and IT projects was introduced previously. The issues of who conducts the strategy (Mendes, 2018) and how it is planned are significant. A classification along broad lines allowed Mintzberg (1994) to categorise strategic planners as left- and right-handed. The left-handed strategic planners were purported as having a greater tendency to call on the left hemisphere of their brain and showed more creativity than their more analytic thinking right-handed colleagues. In the case of teachers, Fidan and Oztürk (2015) concluded a self-perception of their own creativity contributed to a climate of innovation in the school. This hinted at an orientation among educators towards an openness to new experiences from the kind of creative planning seen in their daily work (Bastian, McCord, Marks, & Carpenter, 2017).

Sheppard and Brown (2014) followed a line of contemporary reflection on leadership in schools in the UK and Canada, suggesting that the application of distributed leadership (DL) theory had a role in explaining the workings of a school. Bolden (2011) described DL as a shift of emphasis, from the charismatic leadership of a single individual to adding consideration for the work done by collaborators, as well as the situations encountered during the practice of the work. Structures, functions and roles in organising leadership become less relevant in the study of daily school operations. Harris (2003) spoke of important connections and overlaps of DL with teacher leadership. Teacher leadership is demonstrated by teachers who are able to encourage their peers to change their views or methods without intervention by the formal leader. Research conducted by Harris showed that improvements in student outcomes were more likely in schools with multiple sources of leadership.

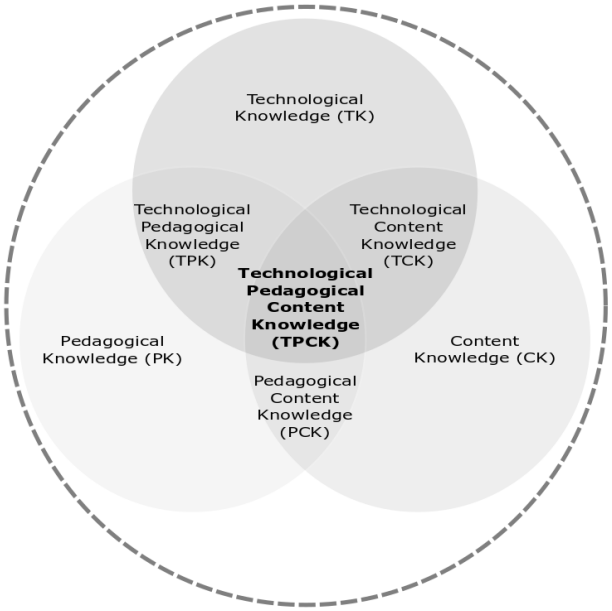

Figure 2. TPACK Framework (M. Koehler & Mishra, 2008)

The framework depicted in Figure 2 has only an indirect relationship to adoption, but was identified as a possible strategy to promote adoption of analytics among

educators during an interview. Therefore, the inclusion of the framework in the literature review became necessary. Voogt, Fisser, Pareja Roblin, Tondeur, and van Braak (2013) presented the Technology Pedagogical Content Knowledge (TPACK) framework as the knowledge base required by teachers to make efficient use of technology in their teaching. The correct use of technology required the pooling of pedagogical and content knowledge, along with technology knowledge. While TPACK might impact the proficiency and effectiveness of teachers, the effect on adoption would be as a consequence, rather that an antecedent, of adoption.

Two main points emerged in this review on strategy as it pertains to schools. First, teachers in that role and ulterior roles as formal leaders may favour an emergent form of strategy over a detailed and articulated plan. Second, when given the choice, teachers throughout their career as educators, opt for the empowerment of being able to make decisions affecting their immediate environment over a top-down decision process.

Adoption. The active collaboration of teachers in adoption is considered a factor of success. A growing body of literature compiled by Sheppard and Brown (2014) suggested the chances of a complex change, brought by a disruptive innovation, becoming entrenched were improved when leadership was distributed beyond principals or district superintendents. The positive association suggested an increase in complexity should be accompanied by an increase in the extent of the authority distribution, as suggested by Bennett (Bennett, 2008) in the context of IT in K-12 and in accordance with DL.

Gil-Flores, Rodríguez-Santero, and Torres-Gordillo (2017) suggested teacher characteristics were more important for IT adoption than resource availability. Although,

the authors took care to specify availability of resources was a prerequisite, they did not consider them a sufficient explanation for technology adoption. The importance of adequate training was not dismissed either. In decreasing order of importance, the authors ranked teacher characteristics ahead of resource availability, whereas adequate resources first had to exist for teacher characteristics to allow adoption.

Table 1.

The Rieber and Welliver (1995) five-step hierarchical model of technology adoption

Evolution	
Reorientation	↑
Integration	↑
Utilisation	↑
Familiarisation	↑

Source: Souleles, Savva, Watters, and Annesley (2014)

The view of adoption in education is influenced by the model of technology adoption in the classroom. A model proposed by Rieber & Welliver (1989) saw a progression in the stages of technology appropriation in the classroom. As seen in Table 1, the original view of the technology adoption process started with familiarisation, then went through stages of utilisation and integration. The revised model of 1995 added two extra stages, reorientation and evolution. The concept of five stages was also seen with the innovation decision process (Sahin, 2006) as explained later in this document.

A conceptual overlap between the two models exists where the entire five stages of the classroom technology adoption model are captured in the fourth and fifth stages of Rogers' (2003) model shown in Figure 6. Familiarisation and utilisation need little introduction. However, the model becomes interesting from the perspective of sustained adoption later in the progression. Integration represents a point of no-return in classroom adoption. With integration, the technology has become rooted into the teacher's work and

is seen as essential. However, adoption can be reversed, and an innovation can be rejected at a later time for another innovation considered more appropriate. The model of classroom adoption (Rieber & Welliver, 1989) sees reorientation and evolution as first a shift where the students replace the teacher as the central concern in the technology. Familiarisation was the teacher becoming comfortable with the technology. Reorientation goes further in the adoption process when the innovation gets used in the classroom for purposes other than the original intent. Finally, evolution reminds the teachers that this technology in its present form is an interim solution. Although intended for educational technology, this model would certainly find a resonance with district leaders in education in dealing with other technologies having an impact on teachers in their classroom.

Analytics. The term 'analytics' covers multiple domains of research. As the term is applied to education, analytics can be divided into three categories: education data mining (EDM), academic analytics (AA), and learning analytics (LA). Table 2 offers working definitions for each approach.

Van Barneveld, Arnold, & Campbell (2012) saw the relevance of business analytics to the field in variants of academic analytics. However, the authors considered academic analytics as an imperfect equivalent to business intelligence when applied to decision making in support of operational and financial matters. Ranjan and Malik (2007) stated data mining, common in a business setting, had far fewer applications in education. As this study focused on educators, operational and financial issues were not in scope, and business intelligence was not a central point of interest.

Table 2.

Definitions of Analytical Approaches

Education Data Mining	Academic Analytics	Learning Analytics
Developing, researching, and applying computerized methods to detect patterns in large collections of educational data that would otherwise be hard or impossible to analyze due to the enormous volume of data within which they exist. (Papamitsiou & Economides, 2014)	Seeking to predict which students are in academic difficulty, allowing faculty and advisors to customize learning paths or provide instruction tailored to specific learning needs. (van Barneveld et al., 2012)	The measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and environments in which it occurs. (Scheffel et al., 2014)
Of interest to:		
District research professionals Superintendents Ministry of Education Parents	Teachers Principals Superintendents	(Principals) Superintendents Ministry of Education

The definition of EDM was noteworthy for not mentioning students or learners. Students and learners provide data used by education data mining, and data mining identifies patterns too difficult to discern without automated assistance. EDM efforts help satisfy the interest of parents for accessible statistics by establishing comparisons between schools and school districts, such as those published by the Fraser Institute (2010) or the EQAO (2014) office. The OnSIS system (Dunn et al., 2013) provides information to the provincial government for budget decisions and improvement strategy.

Definitions for learning and academic analytics made mention of students or learners, and spoke of customising or optimising some aspect of education from information coaxed out of the data. However, classroom teachers would be less interested in the overall environment addressed by learning analytics. Classroom teachers and school principals have a pragmatic mandate, to ensure the best outcomes for the students

in their care. The identification of students at risk and the implementation of remedial education were stated objectives of academic analytics. Principals' interest in LA might be most evident when consulted by the school district's upper echelons, or when working on their school improvement strategies. Day-to-day operations would be informed by AA; teachers would have little need for awareness of EDM or LA.

Following this rapid tour of the education environment and of the terminology used in adoption, analytics and education, a number of theoretical models relating to perception and the adoption of technology are reviewed in the next section.

Theoretical Model

Many theories of IT adoption incorporate perceptions by adopters. These theories can be separated into two categories, according to their focus on the individual or the firm level (Oliveira & Martins, 2011). The theoretical model proposed for this research will consider adoption at both the individual and organisational level, as both levels are salient to the decision to adopt analytics. Therefore, this section will first consider two leading theories of individual acceptance: The Technology Acceptance Model (TAM), and the Unified Theory of Acceptance and Use of Technology (UTAUT); then, two general theories of IT acceptance theories, the Diffusion of Innovations Theory (DOIT) and the Technology, Organisation and Environment (TOE) context theory., followed by a cross comparison of the four theories.

Individual theories of IT acceptance. Individual acceptance of information technology generally follows the conceptual framework shown in Figure 3 (Venkatesh et al., 2003).

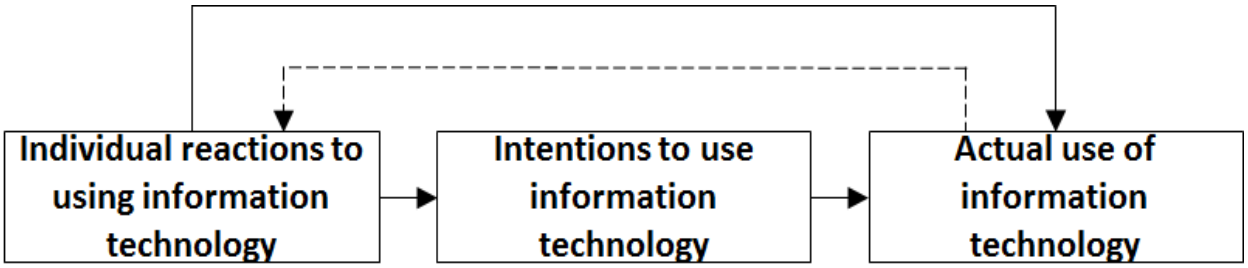

Figure 3. Basic Concept Underlying User Acceptance Models (Venkatesh et al., 2003)

When viewed from an organisational perspective, the adoption of technology consists of multiple individual choices of acceptance (E. M. Rogers, 2003). Figure 3 displays the process of user acceptance common to theoretical models. Perceptions influence individuals in their decision to consider one option over another for adoption, or even to select none of the options proposed (Samithisomboon & Chantatub, 2016). Literature on consumer behaviour suggested the perceptual process was divided into three stages: exposure, attention, and interpretation (Solomon, 2014). At the moment of *exposure*, individuals receive external cues from their senses regarding a product or service and apply a series of filters to avoid being overwhelmed. Through a *selective exposure* filter, clues judged positive and desirable by individuals will be preferred, while any clues considered negative will be avoided. *Selective attention,* or *perceptual vigilance,* determines the degree of attention shown by individuals, according to the relevance of the stimuli received with their needs and wants. In instances where exposure has occurred and stimuli are subconsciously considered threatening, *perceptual defence* will shield individuals from further damage. The last form of filter, *perceptual blocking,* protects individuals from the aggression on the senses of an overly stimulating environment.

At the second stage of the perceptual process, *attention* is triggered by the strongest reaction to a message. Although stimuli are received by all senses targeted, individuals may determine their next actions based on a single impactful aspect of the message. Stimuli are characterised by the format of the message, such as size, colour, format, contrast, and details provided. The level of attention is affected by individual and situational factors. Individual factors might be the interest in or need for the offer presented in the message. The competence or ability of individuals also plays a role in attention, as well as their involvement with the solution proposed. The circumstances of individuals when receiving the message, in terms of surroundings or conditions, constitute situational factors.

The third and final stage of the perceptual process, *interpretation,* is distinct from the various selective psychological filters applied to perceptions. The subjective nature of interpretation allows for great individual variability. Interpretation varies widely between individuals, who combine previous experiences, motives and interests with current reflections to assess the message presented on the product or service. Individuals show a tendency to favour stimuli aligned with their needs, interests and wishes.

An analysis of 32 research papers led Ibrahim and Leong (2012) to conclude that three theories dominate research done on the perception of IT use in organisations. These theories are the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the seven principles for good practice in undergraduate education theory.

Moghawemi, Mohd Salleh, Zhao, and Mattila (2012) chose UTAUT for a study on the perception of IT by entrepreneurs. The social influence component of UTAUT,

abbreviated as SN rather than SI in the relevant literature, relates to how much entrepreneurs perceive people holding influence over them would want entrepreneurs to use new IT technologies. More recently, Ko, Pei, and Tsai (2016) considered the Task-Technology Fit (TTF) model, an extension of TAM, appropriate in the context of IT adoption in the hospitality industry. The seven principles of good practice in undergraduate education theory were established to study and improve teacher-learner and learner-learner interactions (Ibrahim & Leong, 2012), which is not the focus of this research. However, the wide representation of TAM and UTAUT in literature, conducted in the field of IT adoption in a variety of settings, justified that these theories be explored in further detail.

Technology Acceptance Model (TAM). Theories aimed at "comprehending reasons why technology is accepted or rejected by users" (Marangunic & Granic, 2015, p. 84) originated from research in psychology. Limitations in the theories available at the time led Davis (1986, 1989) to build on these earlier theories to develop the TAM. Davis (1986) subscribed to the idea that use of technology could be assimilated to a behavioural response by individuals. However, applying earlier theories to information technology provided unreliable results in explaining technology use. In response to external stimuli affecting individuals, Davis (1986) introduced two distinct user beliefs in TAM - *perceived ease of use* and *perceived usefulness* - to predict *attitude towards use*.

Perceived ease of use measures the difficulties perceived by individuals in learning and implementing the technology. Perceived usefulness indicates the degree of benefit for the organisation anticipated by individuals from using the technology.

Perceived ease of use was considered as having a causal effect on the perceived usefulness. The framework of the original TAM model is represented in Figure 4.

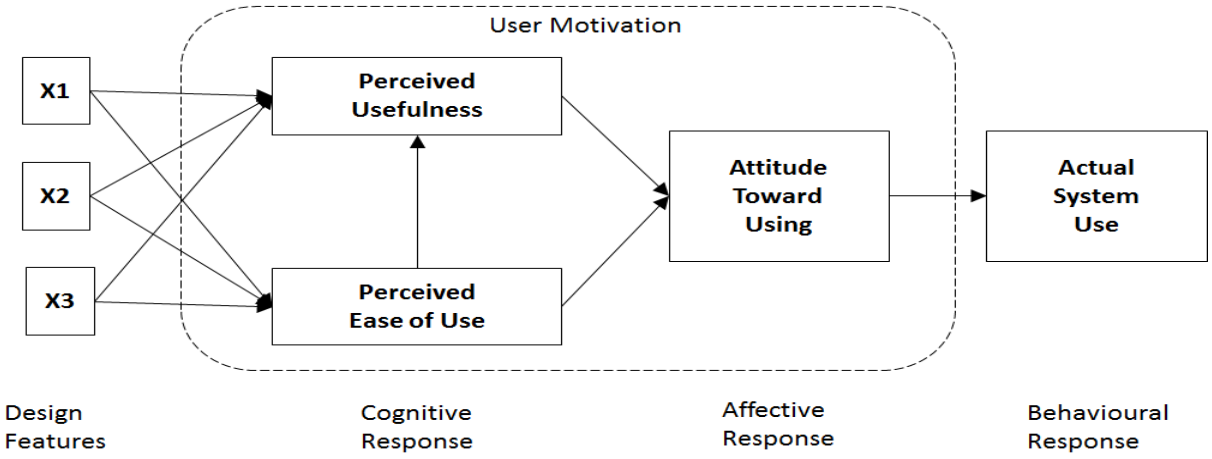

Figure 4. Technology Acceptance Model (F. D. Davis, 1986)

Mathieson (1991, p. 188) suggested combining the Theory of Planned Behaviour (TPB) and TAM to achieve "general and inexpensive information" through TAM and "more detailed information" with TPB. The Theory of Planned Behaviour considers attitude, subjective norms, and perceived behavioural control determine behaviour intention (L. Li, 2010). TAM was deemed easier to use, while TPB gave more insight into factors determinant in the choices made by users. The appeal and success of pairing TPB and TAM together can be seen in a number of recent studies which continue to adopt a similar approach (see, for example, Jin, Chai, & Tan, 2012; Martínez-López, Esteban-Millat, Cabal, & Gengler, 2015; Moqbel, Charoensukmongkol, & Bakay, 2013; Yang, Liu, & Zhou, 2012). However, a combination of TPB and TAM was not retained for this study. A successor to TAM and TPB inspired by these two theories, as well as others, was proposed. This theory, UTAUT is discussed next.

UTAUT. User perceptions of technology play a role in UTAUT as well (Venkatesh et al., 2003). UTAUT, shown in Figure 5, borrowed from 32 main factors or

constructs found in 8 previous theories, including the Theory of Reasoned Action (TRA), TPB, Rogers'(1976) diffusion of innovation theory, and TAM (Moghawemi et al., 2012). The factors were synthesised into three core determinants of behavioural intention, *performance expectancy* (PE), *effort expectancy* (EE), and *social influence* (SN), as well as a determinant of usage behaviour, *facilitating conditions* (FC). According to Oye, A.Iahad, and Ab.Rahim (2014), root constructs from the eight originating theories for the four UTAUT constructs relied on perception. Moderators of *gender*, *age*, *experience* and *voluntariness of use* affected certain factors. The strongest predicting factor, PE representing the belief that the technology offers gains in job performance, was moderated by the age and gender of the individual. EE, or the ease in using the system, was affected by age, gender and experience. All four moderators played a role in SN, an individual's perception of what others inside the organisation usually expect from the individual regarding use of the technology. Age and experience affected facilitating conditions, or the belief in the existence of a suitable organisational and technical infrastructure capable of supporting a new information technology.

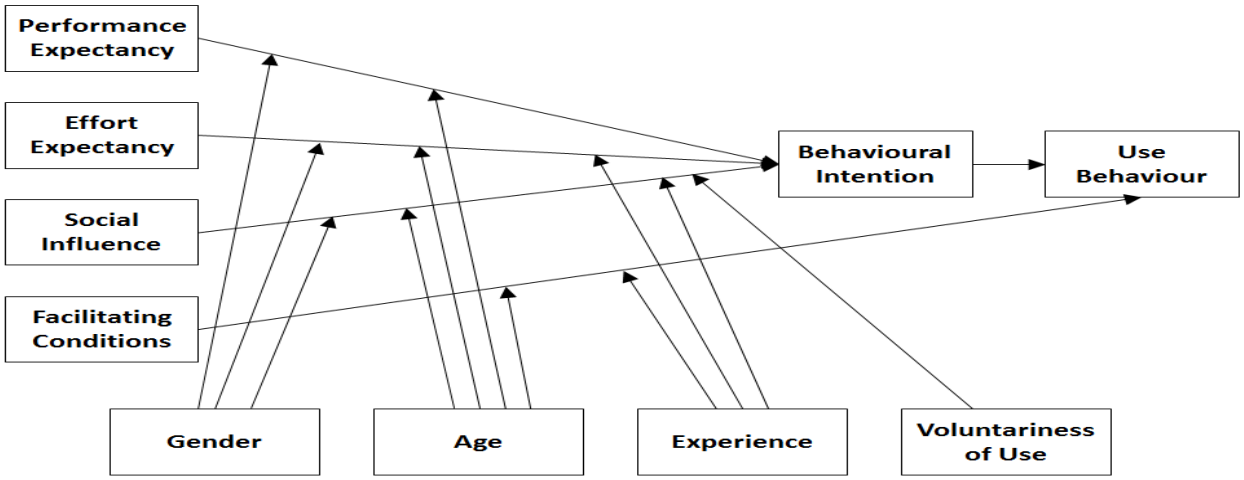

Figure 5. UTAUT Model (Venkatesh et al., 2003)

As part of their attempt to validate UTAUT, Venkatesh et al. (2003) empirically tested their model on a chosen sample. They determined UTAUT explained more of the intention to use technology than any of eight other models. The UTAUT model achieved an adjusted R^2 of 69% while TAM reached only 53% on perceived usefulness. The authors warned of the small size of their test sample as a limitation to generalisation.

A more serious limitation came from attempting to predict actual behaviour from behavioural intention (Moghawemi et al., 2012). This intention-behaviour gap (Moghavvemi, Salleh, Sulaiman, & Abessi, 2015) was subject to three limitations. The first limitation had the consequence of neglecting the impact of external factors on the performance of use behaviour, stemming from the premise that behavioural intention was a reflection of individuals' own beliefs. The second limitation came from the inability of the UTAUT model to correct for new information received by individuals, between when the intention is firmed up and when the expression of the behaviour occurs. The third limitation came from the fact that behaviour outside of the volitional control of the individual, cannot be accurately predicted. Moghavvemi et al. (2015) sought to compensate for those limitations of UTAUT by inserting *precipitating events* between behavioural intention and use behaviour.

Despite the predicting power shown by UTAUT, other models may be even more appropriate, depending on the environment being studied. Brown, Venkatesh, and Hoehle (2015) showed the Model of Adoption of Technology in the Household (MATH) gave better results than UTAUT when trying to explain the purchase and use of technologies by households. Venkatesh, Thong, and Xu (2016) demonstrated that the success enjoyed

by researchers using UTAUT might prevent further research in the field of technology acceptance.

User acceptance models of information technology were proven effective relative to adoption decisions made by individuals in a household (Brown et al., 2015). K-12 district school boards are composed of individuals who make decisions for the benefit of a larger community of stakeholders, as opposed to the number of individuals in a household. A number of researchers showed little hesitation in applying models designed for individuals to organisations (Moghavvemi et al., 2015; Moghawemi & Akma Mohd Salleh, 2014; Rana, Williams, Dwivedi, & Williams, 2012). However, Jeyaraj, Rottman, and Lacity (2006) made a distinction between the use of technology theories aimed at individuals and theories aimed at organisations. Studies reviewed by Jeyaraj et al. (2006) revealed all models presented to this point focused on individuals. Only the Diffusion of Innovation Theory (DOIT) proposed by Rogers (Lundblad, 2003; Rogers, 1976) and TOE framework were noted as being able to bridge between individual and organisational adoption.

Organisational theories of IT acceptance. Organisations are central to theories of IT acceptance at the firm level. DOIT considered internal characteristics of organisational structure, as well as external characteristics of system openness, as being among the determinants of organisational innovativeness. In contrast, the TOE framework included the organisational context in its very name. Each of these will be explained in more detail below.

Diffusion of Innovations Theory (DOIT). DOIT's presence and influence on the field of adoption research is immense. The theory, or references to Everett Rogers, its

creator, appear in articles following other theories on adoption (Corrigan, 2012; Gangwar, Date, & Raoot, 2014; S. S. Li, 2014; Schwarz & Schwarz, 2014). DOIT was among UTAUT's 8 precursor models. Rogers was credited in a brief biography as having written the second-most-cited book in the social sciences (Singhal, 2012). A Google Scholar search in December 2015 identified 69,406 citations for DOIT (Rogers, 2003). DOIT proposes a complete model covering the entire decision process cycle of adoption from initial consideration of an innovation to sustained adoption or discontinuance of use (E. M. Rogers, 2003). The DOIT theory breaks that cycle into five stages, as shown in Figure 6. The stages are affected first by environmental conditions, then by the characteristics of the innovation, as well as by prior conditions throughout the cycle.

Interest in DOIT reached the expected fields of marketing and economics as a natural extension, as well as less expected areas of research, such as the construction industry (van Oorschot, Hofman, & Halman, 2015). Singhal (2012) inventoried contributions made by Rogers' (2003) ideas to agriculture, nutrition, and education. Sahin (2006) reviewed 8 earlier studies attempting to better understand institutional computer use in institutions of higher learning through the use of DOIT. Rogers (2003) considered innovation, communication channels, time, and social system as the four main elements of DOIT. Figure 6 shows the contribution of communication channels and the social system to the DOIT model.

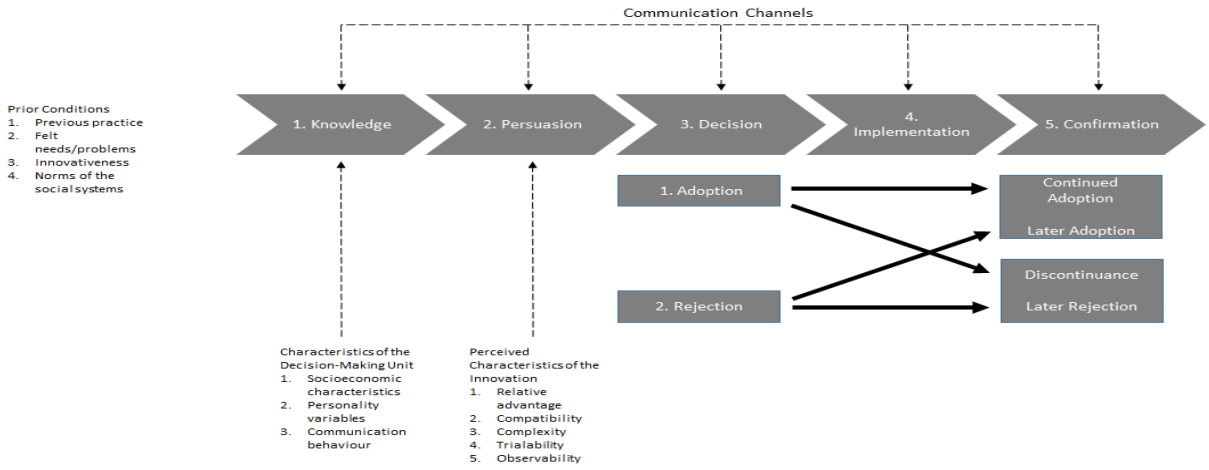

Figure 6. A Model of Five Stages in the Innovation Decision Process (Sahin, 2006)

Perceptions in DOIT are particularly attached to the concept of social system. A group of interrelated units of adoption, having in common the same problem and jointly considering a solution, constituted a social system under the definition proposed by Rogers (Jwaifell & Gasaymeh, 2013; Li, 2014; Puklavec, Oliveira, & Popovic, 2014). The school district being studied, formed the social system for Corrigan (2012). In other cases, the social system could, as is the case in this study, be multiple Ontario district school boards.

The importance of opinion leadership in diffusion of innovations was in evidence with Rogers' (2003) story on the adoption of modern math in Pennsylvania schools in the middle of the twentieth century. The first school superintendent to adopt modern math did not belong to a social circle. Only once, when a group of tight-knit superintendents showed interest in modern math, did diffusion gain strong momentum. In 1960, a year after five superintendents in the initial group adopted, an additional ten superintendents became adopters and twelve more the year after. In five years from 1958 to 1963, all superintendents had adopted modern math. Similarly, Blackburn and Blackburn (2011)

attributed significant credit to the technical competence and familiarity with new technologies possessed by change agents, over the influence of opinion leadership, to explain adoption of new technologies in libraries. The diversity of these applications of theory explains researchers' continuing interest in DOIT. However, DOIT could only return results difficult to interpret without a specific product or service to study for this research. On the innovation's attribute of trialability for example, the issue would be what the subject of experimentation on by users is.

Technology, Organisational, and Environmental (TOE) Framework. TOE was developed as an extension and integration of DOIT and TAM. Existing internal practices and equipment and external technologies available to the firm constitute the *technological context* of TOE. The *organisational context* describes the scope, size and managerial structure of the firm. Finally, the *environmental context* considers the industry, the competitors and the impact of regulatory authorities. The TOE framework is recognised as "a widespread theoretical perspective" (Gangwar, Date, & Ramaswamy, 2015, p. 110) for analyzing an organisation's adoption of IT products or services. TOE held an advantage over other conceptual views in providing a fuller picture of IT acceptance in organisations. This was achieved by the combination of technological, organisational and environmental variables, and independence from restrictions related to the industry an organisation operates in and controlling for size.

Hossain and Quaddus (2011) suggested perceptions played less of a role in initial IT acceptance in cases where regulators applied pressures in favour of adoption. Performance evaluation, rather than perceptions, played a role when considering continued use of the technology. Technology that failed to meet the promised outcomes

was more likely to be set aside and replaced. However, the special case of mandated adoption does not invalidate the significance of perception or belief in a given IT technology.

Individual vs Organisational Theories. Table 3 summarises the commonalities between the different theories reviewed here. Indications of the degree to which later theories owed to DOIT are discernable. In similar fashion, and by deliberate decision, the designers of UTAUT borrowed from all earlier theories. The main concepts of TAM, PE and PEOU have equivalents in UTAUT, DOIT and TOE. However, DOIT's trialability and observability are harder to link to other theories.

Such similarities allowed researchers to combine multiple theories to compensate for difficulties in measuring certain variables. TAM proved versatile by being joined with UTAUT (Barnett, Pearson, Pearson, & Kellermanns, 2014) or TOE (Gangwar et al., 2015).

Table 3

Factors Considered by Theories

	Individual		**Firm**	
	TAM (F. D. Davis, 1989)	**UTAUT** (Venkatesh et al., 2003)	**DOIT** (Rogers, 1976)	**TOE** (DePietro, Wiarda, & Fleischer, 1990)
PE	Perceived usefulness	Performance expectancy (gender, age)	Relative advantage	Technology
EE	Perceived ease of use	Effort expectancy (gender, age, experience)	Complexity	Technology
SN	Attitudes toward using	Social influence (gender, age, experience, voluntariness of use)		Organisation Environment
FC		Facilitating conditions		Organisation
BI	Behavioural intention to use	Behavioural intention		Technology
			Trialability	
			Compatibility	Technology
			Observability	
USE	Actual use	Use Behaviour	Rate of adoption	Adoption

The adoption of analytics in Ontario K-12 district school boards can be compared to the issue of the acceptance of information technology by an organisation. In terms of strategy, decision makers need to answer questions pertaining to the reasons a school district might adopt a particular technology and the manner in which the organisation might benefit from adoption. Given the salient theories relevant to the question of interest, the theories that will be used to frame this study are UTAUT (Venkatesh et al., 2003) and the TOE framework (DePietro et al., 1990; Oliveira & Martins, 2011). Both theories are modern and appropriate to frame and test this study's suppositions. The next section addresses the method used to present an answer to the research questions.

Chapter III – RESEARCH METHOD

The varying degrees to which analytics has become entrenched in Ontario district school boards motivated this study. The research problem was introduced previously, as well as a literature review, to help frame the exploration of the adoption of analytics in school boards. This section presents a description of the research process conducted, and addresses data collection and processing procedures. The discussion on data focuses on constructs and measures, as well as independent and dependent variables. Procedures consist of a description of steps taken for the collection and later processing of data.

A survey and interviews were used to gather the data for this study. A case study format (Yin, 2014) was used to examine the rationale followed by Ontario district school board leaders in education as they considered the adoption of analytics in their organisations and provided hints on how to guide adoption.

Research Method and Design

This study seeks to provide an answer to a research question on the strategies that enable the adoption of analytics by Ontario publicly-funded district school boards. Hawking and Sellitto (2015) submitted that case studies were a suitable investigation tool for information systems researchers. The topic of the research conducted in this document and the ties of analytics with information systems match the aims of a case study. In addition, the use of a survey and interviews in the collection of data allow for a richer discussion of the results in a mixed methods approach. Therefore, the research question and methods selected for this study are aligned with the chosen mixed methods approach of a survey and interviews, interested in analysing a business information systems issue within its context (Gordon, Blake, & Shankaranarayanan, 2013).

Method. The objective of this study, in the form of a case study, was to examine the adoption of innovations, in this case, the adoption of analytics in Ontario K-12 schools. Troshani et al. (2011) applied a case-study methodology in a study on the adoption of innovation management software. Bezboruah, Paulson, and Smith (2014) also applied a case study approach while doing interviews of nursing home administrators, to understand the process of IT adoption in the health sector. For their study, Bischoff et al. (2015) opted for a mixed-method approach, where qualitative data from interviews and quantitative data from a survey were combined to inform a case study on the continuous use of Business Intelligence (BI) systems. All three studies were case studies with semi-structured interviews and dealt with issues of adoption of computer technology. The mixed case approach and survey found in the three studies discussed are found in this study.

An objective of economy and efficiency dictated the choice of a mixed case approach. As discussed in Chapter 2, school district senior leaders in education have little time available. Extraneous activities such as participation in studies by external researchers are not a priority. A short survey following the UTAUT theory, with additions from TOE, produces quantitative data for a limited time commitment to participants. The same focus on minimising nuisance from external research can be said of qualitative data gathered from a few purposeful, semi-structured interviews. Quantitative research attempts to confirm or refute one or multiple hypotheses. Qualitative research provides new understanding by describing and explaining the actual manner in which business is conducted in a real-life situation that is poorly understood (Eriksson & Kovalainen, 2008). This type of research can also point out ways to modify the circumstances for an

improved outcome. As this study seeks to gain a better understanding of processes leading to adoption of an innovation, a mixed method design for this study was preferable to a pure quantitative or qualitative design. Insight was gained from the analysis of answers to survey questions and data gathered during one-on-one interviews with participants. Although it is not predicated, the outcome of a case study could form the basis of a working theory. Due to intended and unintended limitations in the access to data, as well as the exploratory nature of the work, the generalisation of findings from this study and their immediate applicability beyond the sample population are not to be expected.

Research design. The absence of known literature on the adoption of analytics in Ontario school districts translates into a lack of understanding of the mechanisms at play in the decision-making process. For that reason, the design for this study was an exploratory single case study. This design approach allowed a focus on the dynamics of a small group (Yin, 2014), school district administrators. Case studies following an intensive design focus on exceptional individuals may, in this instance, obscure insight instead of increasing understanding. This research adopted an extensive case study design and required the collection of empirical data from the district administrators. It also focused on meaning among the categories of research interest mentioned by Eriksson and Kovalainen (2008), rather than the characteristics of language, the discovery of regularities, and reflection. The semi-structured interviews recorded by Bezboruah et al. (2014) for their case study allowed the researchers to identify a number of recurring themes as part of the adoption of health information systems innovations. Questions in that particular study were laid out in a guide to avoid interviews getting off track and to

promote efficient gathering of information. Because of these advantages, a semi-structured interview was used for the qualitative purposes of this research.

In order to be approved by competent authorities, this study needed to use few school district resources, be limited in time, and remain within scope. Research designs based on ethnographic, grounded theory, focus group, action, narrative or discursive action were considered and discarded for this study. Ethnographic and action research often require embedding the researcher in the midst of the subjects. Logistical constraints in time, geography and work commitments rendered that option difficult to implement. Focus group or grounded theory were also rejected as they call for joint or repeated sessions with the subjects, when the design specifies a single interview with each participant. The narrative and discursive research designs were also unsuitable for this study as executives would likely be unwilling to dedicate a lengthy period of time to hold an open-ended discussion on a matter they had a brief involvement with some time ago. Limited documentation availability on the subject prevented a narrative or discursive analysis.

The reasons given above indicate why other research designs were unfit to the task of addressing the issue. For reasons tied to access to the participants, a case study is best suited for this research. Yin (2014) stated that the case study is an appropriate research design for analysing in its context the behaviour of a small group of people on a current issue. For the purpose of this study, the UTAUT model with extensions from TOE in relation to organisational size formed the foundation of the quantitative analysis for its predictive efficiency and broad acceptance by researchers on technology adoption. The quantitative data that were collected using a survey are outlined below.

The Data

Variables. The UTAUT model borrows from human behaviour theory to analyse intentions to use technology by end-users. In its basic form, UTAUT postulates three factors - performance expectancy (PE), effort expectancy (EE), and social influence (SN) – as having a positive influence on behavioural intention (BI) to use a system. In turn, BI, and facilitating conditions (FC), impact actual use behaviour (USE). Therefore, four independent variables are expected to predict the dependent variable user behaviour (USE). A variable from TOE, size is also introduced as part of FC. The student enrolment figures for the 2013-14 school year, found in Appendix A (Queen's Printer for Ontario, 2016a), served as a measure of size. Values for other variables were obtained from survey data and from the corporate web sites of the two school districts concerned by the study.

Instruments. Data collected for this study provided insight on the main research question regarding the adoption of analytics in Ontario school districts. The data also addressed the peripheral research question related to enrolment size. A study on E-Health systems diffusion (Spil & Schuring, 2005) used the same instrument selected as the survey used for this study. Face validity was performed by discussing the survey with a school vice-principal and a school district researcher. However, the reliance on a survey instrument already validated by Spil and Schuring meant a pilot test of the survey could be avoided for the validation of survey questions (Kitchenham & Plfeeger, 2008).

The survey instrument consisted of 24 questions organised around 6 variables of the UTAUT model: performance expectancy (PE); effort expectancy (EE); social influence (SN); facilitating conditions (FC); behavioural intention to use the system (BI); and, user behaviour (UB) moderated by individual differences in age, gender, experience

and voluntariness to use (Venkatesh et al., 2003). Information for this study was gathered from completed surveys and answers to interview questions obtained during semi-structured interviews conducted in person and recorded. Each interview followed an identical format. Appendix B includes a copy of the survey instrument, while Appendix D includes the interview protocol used for each participant.

The analysis of qualitative data is subject to bias by the interviewer. Analysis requires reflexivity on the part of the researcher. For Lacity and Janson (1994), as the language resulting from the interviews can be viewed under one of three traditions: positivist; linguistic; and, interpretivist. In this study, language was assumed to have a subjective meaning and a researcher's responsibility was to consider the speaker and biases in assigning meaning to the language. As such, an interpretive approach was employed in the analysis of the text. However, a high degree of homogeneity among teaching staff is likely, as they are individuals with very similar backgrounds, from their early days as preservice teachers (Zimpher, 1989) to their training to become supervisory officers.

Concerns over validity take a different form in qualitative research and test-retest reliability or internal consistency in quantitative measurement validity are replaced by transferability to different contexts or confirmability by other researchers (Venkatesh & Brown, 2013). Confirmability remains elusive when little work has been done in the specific area of adoption of analytics by Ontario school districts. However, transferability to health care or small and medium enterprises may be established by studies in these various other contexts (Puklavec et al., 2014; Wills, 2014; Wixom et al., 2014) and, by extension, to school boards.

The data collected for this study were, and continue to be, maintained according to University rules governing their retention. Data will be available upon request from the researcher for 5 years past the completion of the study and kept in a secured container for 5 years, after which all data will be destroyed.

Population and Sampling

The study participants were drawn from the population of administrators in two Ontario school districts. Ontario superintendents in K-12 education are appointed by school districts and are confirmed by the Minister of Education as supervisory officers (Ontario Ministry of Education, 2011). Superintendents certified as academic supervisory officers are in a better position to connect student success with analytics and were preferred over business supervisory officers. However, since business supervisory officers bring a different perspective, they were not excluded from participating. However, no business supervisory officers volunteered to participate.

Researchers using the UTAUT theory consider gender significant in technology adoption (Venkatesh et al., 2003; Venkatesh, Thong, & Xu, 2012). Rogers' (2003) references to gender in DOIT were incidental and little can be derived from his comments apart from gender affecting the composition of the social systems. Literature on the subject of technology adoption points to gender difference in the relative importance given to innovation characteristics and in the communication about the innovation (Ilie, Van Slyke, Green, & Lou, 2005). Women showed interest in usability, while men favoured task-completion. As participants from both genders are likely to cover a wider range of perspectives during data collection, a random sample consisting of female and male administrators, very similar to the target population of the two districts studied,

were secured and utilised for the study. Table 6 illustrates the position held, gender and age representation of the sample.

Administrators from one large (more than 22,000 students) and one small (under 10,000 students) English school district formed the subjects of the case study. Following formal acceptance required by internal policies and procedures governing external researchers of the large district to participate, contact via mail was maintained with the superintendent of that board responsible for a board-wide analytics initiative, with an explanation of the intent of the study. Contact via mail was facilitated with the smaller board, as it did not have formal policies and procedures with respect to external researchers. Surveys were made available online via the SurveyMonkey platform and collected from willing district participants (potential N = 194). SurveyMonkey was familiar to participants and was believed by one researcher of the larger school district to inspire confidence in recruiting participants. One supervisory officer from each district and, after multiple recruitment campaigns, one school principal volunteered for participation in the interviews. Despite a low level of participation in the study, the estimated saturation of themes was achieved. Marshall, Cardon, Poddar, and Fontenot (2013) noted additional participants brought diminishing returns past theoretical saturation.

Yin (2014) held strong views on using terms such as *sample* or *purposive* when working on one or many cases. His views expressed an opposition to referring to the concepts of sample or of a purposive sample, as they contradict the spirit of a case study and the pursuit of statistical generalisation. However, the most apt description for the non-random selection of participants, according to the researcher's judgement in

achieving the intent of this study and applied in this study to the selection of interview participants, would be a purposive sample (Hazen & Byrd, 2012).

The appropriate size of the sample for qualitative case studies is an issue debated in academic literature. Mason (2010) criticized PhD researchers for unnecessarily inflating the sample size in their thesis or dissertation to avoid issues during examination. Marshall, Cardon, Poddar, and Fontenot (2013) qualified of a major crisis the casual attitude of qualitative IS researchers towards justifying the sample size of their studies . Perhaps at odds with Yin's (2014) position, a statistical demonstration of saturation was one recommendation by Marshall et al. (2013). However, consensus on the need for a sample sufficient in size to achieve saturation with qualitative methodologies other than grounded theory was questioned by O'Reilly and Parker (2013). The *appropriateness of the data* prevailed over considerations tied to the size of the sample. For these reasons, setting sample size appears to be determined by what is deemed appropriate by the researcher. Earlier expectations regarding the number of interview participants had to be adjusted to the reality of the participants willingness to participate. Consequently, for the purposes of this research, the sample size consisted of four interviewees.

Data collection technique. Case studies draw from multiple sources for data collection (Farquhar, 2012; Yin, 2014). Yazan (2015)) pointed at differences among acknowledged case study researchers, (e.g. Yin, Merriam and Stake). Unlike Merriam and Stake (1995), Yin (2014) advocated the mixing of qualitative and quantitative sources to achieve triangulation. Triangulation presented some drawbacks for Jick (1979), making replication complex, when a problematic juxtaposed answer is provided for a malformed question, or where the qualitative and quantitative evidence are used to support one

another. Given the purpose of the proposed research, and the desire to achieve triangulation, as advocated by Yin (2014), this research combined a quantitative survey with qualitative interviews in terms of the data to be collected.

The survey questions found in Appendix B were designed and validated as part of a study conducted by Spil and Schuring (2005), which measured electronic health systems diffusion and use. A few questions of interest were added at the request of researchers from the larger board. These other questions improved on the classification of respondents

This survey instrument was distributed in electronic format to 194 educators working located in the 2 school districts. The survey was administered under the SurveyMonkey platform. Possible concerns over data being stored in the U.S., and therefore possibly being subject to the Patriot Act, were addressed with the Ethics bureau of Athabasca University and permission was granted. Identification of which of two possible districts a survey originated from, while respecting the anonymity of the respondents themselves, was not performed. The small size of the survey dataset would not yield much information in linking answers back to the district size.

As part of the survey, individuals were invited to submit their name if they were willing to participate in a telephone interview. Two school principals volunteered when told in district meetings that this study was taking place. Among the two executives interviewed, one was an institutional sponsor of this research, while the other executive consented to participate at the request of the sponsor. All four interviews were conducted in person in the interviewee's office after agreement was reached on a schedule convenient for both parties. The consent form was emailed prior to the interview for

perusal by the interviewee. The interview questions appear in 0. The geographical proximity of participants to the researcher negated initial concerns of face-to-face meetings across a province as large as Ontario, and the option of face-to-face meetings became practical in terms of time and cost for participants and the researcher. All interviews took less than 90 minutes driving time for the researchers and ensured interviews were conducted under identical conditions and with a higher likelihood of the participant's presence. Interviews took place at the end of the 2017-18 school calendar, when the target population was under heavy pressure to close the year. Indicative of the commitment and interest of the participants, no postponement or rescheduling of any of the appointments was necessary.

Interview participants were made aware of their right to refuse the recording of their interviews, either before or during the interview. Appendix F presents the signed release covering participation and recording obtained at the beginning of each interview and filed securely afterwards. An Olympus WS-852 digital voice recorder was used for recording once permission was granted in writing in every case.

The memory of the recorder was verified as empty before the start of each interview. After the interview, the recording was transferred to a computer file named according to a coding sheet to protect the anonymity of the interviewee and the content of the recorder was erased. A second redundant recording device in the form of a smartphone was also used in case of technical issues with the digital voice recorder. Systematic application of this procedure avoided exposing the identity of participants should the recording devices be lost. In practice, participants knew of each other and the first participant referred to the other three. Therefore, and outside of the researcher's

control, the identity of participants was known among the four participants. Confidentiality outside of the group was maintained.

Interviews were mechanically transcribed by a voice recognition application. The researcher then spent several days correcting the output by comparing the recording with the transcription. A copy of all transcriptions was then stored in a locked cabinet in the researcher's office and sent to the respective participants for verification.

Analysis

Data organisation technique. Organised data was an aspect Baxter and Jack (2008) reported, and Yin (2014) and Stake (1995) both agreed on its importance to reliability. As such, reliability was established by maintaining the case study database recommended by Yazan (2015). This database was maintained in a Microsoft Access database and transcribed text indexed with a code, indicating participant and time of interview. Another database was used for the *qualitative analysis software* (QAS) (Abreu & Acker, 2013; Piotti, 2012) and could have been rebuilt if lost from the Microsoft Access database (Straumsheim, 2014). Transcription took place as soon as possible after the end of the interview. Recollection of recent events assisted in drawing a richer picture of the circumstances of the interview. English texts are necessary for the analysis tool selected and consistency of themes uncovered. The texts were loaded in collated form into the QAS for later analysis. Research logs were kept to document the steps taken for reconstructing the evidence. A reflective journal enabled progress tracking as new avenues of research and themes emerged.

Electronic and paper documentation will be kept for 5 years in a secured container. Electronic data was copied on SD cards. Though the pace of technological

change may be a cause for concern (Hajtnik, Uglešić, & Živkovič, 2015; Hellmer, 2015), SD cards are currently an ubiquitous electronic storage format and should still be readable within the 5 year timeframe. At the expiration of the term, the SD cards will be physically destroyed if obsolete or erased using US National Institute of Standards and Technology guidelines for media sanitisation (Kissel, Regenscheid, Scholl, & Stine, 2014) or revised best practices at that time.

Data Analysis Technique. The data analysis for this study focused on two data sources of adoption of analytics by Ontario school districts. The quantitative analysis of survey data used structural equation modeling (SEM) to confirm if assumptions of the UTAUT model were valid in this context. The qualitative analysis concerned the transcribed text and theme extraction from the interviews. The data-coding scheme was designed to address the research question from the data collected. Three tools were used for data analysis to consider the different aspects under consideration, as outlined below.

The SPSS package provided graphical representations of the data. and was also used for post-coding of the survey data. The SmartPLS package was used for SEM processing (Rosseel, 2016). Data issued from interviews was analysed with NVivo (version 11). All three software packages were installed on a separate local computer with limited network access to prevent any theoretical issues in preserving the confidentiality of the data (Demirkan & Delen, 2013). The choice of the NVivo software for the qualitative analysis followed the advice of Yin (2014) to focus on the analysis, rather than on the tool.

Ethical Research

The Athabasca University Research Ethics Board (REB) reviews proposed research studies involving humans. Approval from the REB is contingent on ensuring research involving humans is conducted in accordance with the highest ethical standards. Data collection for this study took place once the REB granted its approval to the request. Research was performed according to the rules and the terms of the REB approval, to ensure the fair and ethical treatment of participants.

A REB application form was completed and submitted online in compliance with Athabasca University, federal and provincial policies. A copy of the approved REB form appears as Appendix E. All potential and actual participants received a consent form (Appendix F) inviting them to take part in the study and providing a brief description of the study's purpose. The form stressed that participation was voluntary and participants could decline to answer any question for any reason. The form informed participants of their right to withdraw from the study at any time during the data collection phase and indicated that participation incentives were not offered as part of the study. A follow-up telephone call was made to 12 invited districts who had not confirmed their interest to participate, in the two weeks following the sending of the forms. All school districts contacted indicated their lack of interest in participating over the phone, or via electronic mail.

Aware of the research and lack of success in securing access to data for this study, a superintendent of schools expressed interest in the study and became an active sponsor and advisor. The superintendent instructed the internal research group to assist the researcher with the district's application process. A first application submitted in August

2017 was rejected. A second application, submitted with the direct involvement of the sponsor in January 2018, was accepted. Data were collected under the terms of the Athabasca University REB and the approving school district application. The smaller school district entrusted the acceptance process for external research to the director of education. Data collection in that second district was conducted according to the REB obtained for this study.

Interviews were recorded since all participants were informed of their right of refusal and granted their permission. Coding of participants' identifiable information ensured the privacy of participants and their right to anonymity. Electronic data, data collected during interviews as notes and signed informed consent forms are kept on removable media and will be stored in a locked box for 5 years after completion of the research. To avoid incidents of lost data (Straumsheim, 2014), an encrypted backup of these data is maintained in a managed data storage environment.

The discussion on the findings in the next chapter address data collected from the survey and interviews.

Chapter IV - FINDINGS

This chapter presents the findings of the study from the data collected in the survey and the interviews. The first section looks at the results from the survey, the second section analyses information gathered during the interviews, and the chapter closes with a discussion of the findings before the conclusion.

Research Findings from Survey

This section, dedicated to an analysis of the data produced by the survey, is divided into four parts as outlined below.

The first part provides a brief description of two critical concepts, reliability and validity, as they pertain to data. The second part is a descriptive analysis of the data, using the statistical package for the social sciences (SPSS), to provide information about the environment studied and how this environment resembles or deviates from Ontario publicly-funded K-12 education in general. In the third part, the discussion moves to an inferential analysis, aligning the investigation of the survey data according to the major themes of the research. Finally, the section ends with a brief summary and conclusions.

Reliability and validity of data. As they apply to collected data or statistical estimates, the concepts of reliability and validity have their place in any discussion on data. Hair, Hult, Ringle, and Sarstedt (2016) used the analogy of an archery target, in which a concentrated set of arrow strikes on the target over a small area indicates a reliable archer, as the archer is able to repeat his or her performance consistently. Reliability does not imply an automatic high score defined by the proximity of these arrows to the centre of the target. The archer could be consistently hitting the target off-centre in a close grouping and be thought of as reliable. Therefore, validity is also

required, as it measures proximity to the bull's-eye. Validity implies a close grouping of the arrows near the centre of the target. A high score demands that the archer hit the target often and dead center. In a similar manner, data cannot be valid if they are not also reliable. With the understanding that reliability and validity are goals of a credible study, the descriptive analysis can now be presented.

In terms of reliability, the data for this study was an accurate sample of the population as shown in Appendix C. As indicated, repeatability of the qualitative and quantitative data collection to increase reliability was not feasible. However, the recurrence of the same themes during the interviews suggested theoretical saturation. As for validity, the use of the survey instrument found in Appendix B, validated in another study, indicated the suitability of the experiment and ensured what was meant to be studied was, in fact, gathered. The validity of the interview questions was submitted to the examination of two individuals and interview transcripts were sent for review by participants.

Descriptive analysis. This analysis presents a description of the data collected as part of the study. The analysis considers frequency statistics and graphical representations of the data (Simpson, 2015). An overview of the sample and population sets the stage for later discussions.

Background on the sample and the population. The number of educators in leadership positions in the two school districts involved in the research was 194. The survey was answered by 58 respondents, equivalent to a response rate of 29.9 percent. That figure is consistent with the typical participation in surveys considered internal by organisational leadership (Baruch, 1999). The number of respondents and the size of the

cohort provided at least a 10 percent confidence interval at a 90 percent confidence level of obtaining a correct response to one of the survey questions (D. R. Cooper & Schindler, 2014). As all questions were mandatory, no special accommodation was necessary to handle missing data.

The sample of survey responses is a combined dataset of respondents from both districts that were targeted. The same SurveyMonkey web address was provided to the staff of both districts. As a result, survey responses from all respondents were merged into the same dataset. Later attempts at using the internet address of origin of the participants stored by SurveyMonkey to differentiate school districts could only unambiguously identify two responses as coming from respondents of the smaller school district. With 32 possible respondents in the smaller district and the balance of 162 in the larger school district, considering the survey responses as originating from a single population of 194 appeared preferable in order to reduce small sample size effects (Royall & Royall, 2016).

The survey. The survey instrument appears in Appendix B. Questions were adapted to the context of analytics in school districts from extant research, using UTAUT as its theoretical framework (Spil & Schuring, 2005; Venkatesh et al., 2003). Twenty questions measured the common variables found in UTAUT: performance expectancy (PE); effort expectancy (EE); social influence or norms (SN); facilitating conditions (FC); and behavioural intention (BI). The data collected included age, experience, gender and voluntariness of use, factors postulated by the UTAUT theory to have an impact on the use of an innovation (USE). Another question was directed to identify analytics tools

likely to be used by respondents. Table 4 presents a summary of the number of questions related to a UTAUT-specific variable.

Table 4

Variables and Number of Questions

Variable	Number of Questions	Survey Question Number
PE	4	5.1-5.4
EE	4	6.1-6.4
SN	4	7.1-7.4
FC	4	8.1-8.4
BI	3	9.1-9.3
USE	5	2,8.5,10,11,12

Data take on different attributes when loaded in SPSS. Each piece of information must be assigned the appropriate measure of either ordinal or nominal, according to what the data represents. The assignments of type of measure to the variables is discussed next.

Types of data. A rating scale, following a Likert scale format, was used for the UTAUT variables, where 0 = not applicable, 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. In similar fashion, other variables were recoded in ascending numerical values and given meaningful labels in SPSS. Data obtained with this survey using Likert scales are ordinal by their nature (J. Robertson, 2012). Similarly, data such as the number of years in the position as a measure of experience, are also ordinal.

Ordinal data give an order or rank as well as a classification to information. Responses ranging from ‘strongly disagree’ to ‘strongly agree’ appear on a scale which can be visualised from least to most. However, there is no indication of distance between any of the points on the scale. Other data such as gender or the position held are nominal (D. R. Cooper & Schindler, 2014). Nominal data do not have the characteristic of order. Information on gender is factual and no ranking is implied from belonging to one

category or another. None of the information collected is of the ratio or scale type. For example, the age of respondents when expressed in a unit of measure, usually years, qualifies as a ratio scale. This level of detail was not necessary for this research and was considered intrusive. Therefore, to strengthen confidentiality, collection of information on age was done as an interval variable.

The type of data also affects their interpretation. For example, the mean of the gender values collected would be meaningless and only measures such as the frequency or count, mode or median would prove useful in that case. Non-parametric tests would also be necessary to test assumptions. Although not needed from a conceptual point of view, in the case of some variables, the post-coding of survey data within SPSS was made necessary by the SmartPLS software, as it requires numerical values in its computations. Table 5 summarises each variable and its scale type in their order of appearance in the survey (D. R. Cooper & Schindler, 2014).

Table 5

Variables, Meaning and Type of Scale

		Variable	Type of Scale
1		Current Assignment	Ordinal
2		School Enrolment	Interval
3		Familiarity with Tool(s)	Nominal
4		Frequency of use	Ordinal
5	*	I find analytics useful in my job (PE1)	Ordinal
6	*	Using analytics increases the chances of achieving things that are important to me (PE2)	Ordinal
7	*	Using analytics enables me to accomplish tasks more quickly (PE3)	Ordinal
8	*	Using analytics increases my productivity (PE4)	Ordinal
9	*	Learning to use analytics would be easy for me (EE1)	Ordinal
10	*	The results generated from analytics would be clear and understandable to me (EE2)	Ordinal
11	*	It would be easy for me to become skillful at using analytics (EE3)	Ordinal
12	*	I would like to learn more about analytics (EE4)	Ordinal
13	*	People who are important to me think that I should use analytics (SN1)	Ordinal
14	*	People who influence my behaviour think that I should use analytics (SN2)	Ordinal
15	*	The use of analytics is encouraged by senior management (SN3)	Ordinal
16	*	In general, the organisation has supported the use of analytics (SN4)	Ordinal
17	*	I have the resources necessary to use analytics (FC1)	Ordinal
18	*	I have the knowledge necessary to use analytics (FC2)	Ordinal
19	*	Analytics is not compatible with other systems I use (FC3)	Ordinal
20	*	A specific person (or group) is available for assistance with analytics difficulties (FC4)	Ordinal
21	*	The school board should mandate the use of analytics (MandatoryUse)	Ordinal
22	*	I plan to continue using analytics in the future (BI1)	Ordinal
23	*	I try to use analytics in my daily routine (BI2)	Ordinal
24	*	I want to become more proficient with analytics (BI3)	Ordinal
25	*	How long have you been in your current position (TimeInPosition)	Interval
26	*	Please indicate your gender	Nominal
27	*	Age Range	Interval

Note: The asterisk denotes a variable used in the estimation of the UTAUT model.

Skewness and kurtosis. Erroneous conclusions could be drawn based on significance, as a result of data following a non-normal distribution. The application of this technique, found in the inferential analysis section later, makes no assumption and has no requirement that input data are normally distributed. Although the estimation technique selected for this study is non-parametric, the assessment of the statistical significance of results from data exhibiting strong non-normal distribution becomes delicate, as standard errors can be magnified. Skewness and kurtosis are two measures of

distributions helpful in determining if data follow a normal distribution in the typical bell curve shape graphical representation. Skewness indicates the degree of symmetry around the mean of the values. Kurtosis assesses the level of spread around the mean. These measures vary from -1 to 1, and values near 0 on both measures represents the perfect case. Appendix H presents the skewness and kurtosis values for all data collected, even variables.

A review of the data can now be conducted by separating the data into two parts: the first part looks at variables which provide a demographic snapshot of the sample; the second part considers the remaining variables included as part of the UTAUT model.

Demographic variables. Certain variables describe group characteristics of the individuals who participated in the survey. One such characteristic is the type of position held by respondents at the time of the survey. Current positions held in the sample data ranged from vice-principal to principal, in either elementary (K-6) or intermediate/secondary (7-12), to supervisory officer. Other groups of educators appeared as options in the survey for inclusiveness, but individuals in these groups were not invited to participate and none participated. Twenty-eight elementary principals represented almost half of respondents. The underrepresentation of supervisory officers was likely the result of the separation of their duties into distinct portfolios. Eisenhardt and Santos (2005) explained how organisational boundaries could prevent a supervisory officer, unfamiliar with analytics and considered an activity associated with technology, from being seen as interfering in a peer's area of responsibility outside of their own portfolio. Regardless of the correctness of the interpretation for a low participation by executives in

the survey, Williams and Karahanna (2013) criticized the effect on IT projects of a silo mentality in promoting unit objectives over organisational objectives.

Demographics on the position held by the respondents, as well as their age range and gender can be found in Table 6.

Table 6

Position, Age range and Gender of Respondents

	Age Range										
	30-35		36-40		41-50		51-55		> 55		
Position held	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Total
Vice-principal elementary	0	0	1	0	2	1	3	0	0	0	7
Vice-principal intermediate/secondary	1	0	2	1	6	2	0	1	0	0	13
Principal elementary	0	0	0	1	10	3	3	4	6	1	28
Principal intermediate/secondary	0	0	0	0	3	2	0	3	0	0	8
Supervisory Officer	0	0	0	0	0	0	0	1	1	0	2
Total	1	0	3	2	21	8	6	9	7	1	58

A comparison of percentages of position held, gender and age indicated the sample was a close match with the population. Appendix C presents the data for population and survey sample on these three variables. The manner in which values for some of these variables on the population were obtained was indirect. The position held by the leaders in education of the two school districts was obtained from the corporate school district or the individual school web sites. Gender was based on given names and confirmed, when ambiguous, from various sources, including school newsletters. The age range of population members was an approximation derived from public information gathered from the Ontario College of Teachers (2018) as to the year individuals graduated from university and obtained their Bachelor of Education degree. The assumption made was that teachers would have reached at least the age of 23 by that time. The measure of

age became the difference between present and assumed year of reaching age 23, which was then broken down in the same intervals that were used in the survey. An example of similarity between sample and population, the population was comprised of 66 percent female, while the sample consisted of slightly more that 67 percent female. One exception concerned the lower participation of the supervisory officers, compared to their prevalence in the population of individuals at the top of the hierarchy. As would be expected, senior administrators in education would have reached a top position later in their career at a greater age (Gayle, Golan, & Miller, 2015). This may, in turn, explain the lower percentage of survey respondents in the highest age group.

The below 30-age range column was removed from Table 6 since no respondent fell into that category. The most represented category with 29 respondents, or 50 percent in the sample, consisted of individuals aged 41-50. Retirement benefits afforded by the Ontario Teachers' Pension Plan allow its contributors to retire from the age of 50, or after 30 years of service, with an unreduced pension (OTPP, 2018). In this context, Gayle, Golan and Miller (2015) wrote that individuals would be expected to reach top positions in their organisation towards the end of their career, corresponding to the most common age range in the sample.

The predominance of women leaders in education is apparent from Table 6. The gender ratio was about two-thirds to one-third. This gender imbalance in favour of women is a known fact in education across Ontario and held true in this sample. However, caution is advisable, since a strict observation of ratios would point to one small discrepancy from the population or the situation in Ontario. All within the sample's

confidence interval, secondary principals represent 51 percent, rather than the 62 percent, of the sample (Queen's Printer for Ontario, 2016b).

Another characteristic of the respondents was their reported experience in their current position. The time intervals used were found in extant academic literature. The frequency data provided as Table 7 shows that most respondents had at least 4-7 years at their current position. A minority of 37.9 percent had been a supervisory officer, principal or vice-principal for less than 4 years. This attests to the maturity attained by a majority of the respondents in their role. However, consistent results, in a Canadian context over 40 years of research, showed that school performance, evaluated from student achievement or staff leadership, was not clearly correlated to the experience of their principal (Dhuey & Smith, 2014; Fiedler, 1972). Other factors, such as the size of the school, which is discussed later, were more determinant on school performance. Therefore, the results required by the model are presented as facts, while their interpretation is uncertain.

Table 7

Time in Current Position

	Frequency	Percent	Cumulative Percent
less than 1 year	6	10.3	10.3
1-3 years	16	27.6	37.9
4-7 years	17	29.3	67.2
8-15 years	17	29.3	96.6
more than 15 years	2	3.4	100.0
Total	58	100.0	

Instead, the discussion will focus on the graphical representation of the current assignment and the time in the current position, as presented in Figure 7. Yang, Harrison, Rensink, Franconeri, and Chang (2018) confirmed visual cues were commonly employed

by researchers to evaluate characteristics of the data. Demiralp, Haas, Parthasarathy, and Pedapati (2017) agreed on the value brought by visual insights on the data. Figure 7 suggests a bell-curve or normal distribution of the time in a given position. Kurtosis and skewness values confirm the visual appreciation regarding a normal distribution of the data, respectively -0.010.and -0.056, as shown in Appendix H.

An exception can be noticed in the role of elementary principal, with a large number of principals having 8-15 years in that role. Hints of an explanation can be found in the inner workings of the larger district surveyed. Firstly, high schools each have more than one vice-principal, with an individual focus on either the intermediate or secondary panel. The separation among panels is not absolute and any vice-principal will address urgent cases regardless of a student's grade level. Larger high schools could have a staff establishment of three vice-principals to handle the greater workload. Secondly, a smaller total number of elementary vice-principals was to be expected, since only large elementary schools have a vice-principal. Thirdly, a number of elementary schools, 6 or more, feed a single high school. Therefore, the larger total number of elementary principals should be, and is, reflected in the sample. Finally, regarding the larger number of elementary principals with 8-15 years' experience, an internal rule requires a principal to hold, among numerous other qualifications, experience as a secondary principal before becoming eligible for one of the few supervisory officer positions once a vacancy opens. Whereas advancement remains a possibility for secondary principals, elementary principals may never aspire to push their career in that direction. Motivations for a principal to seek an executive position are, as pointed out by Davis and Bowers (2018), highly individual.

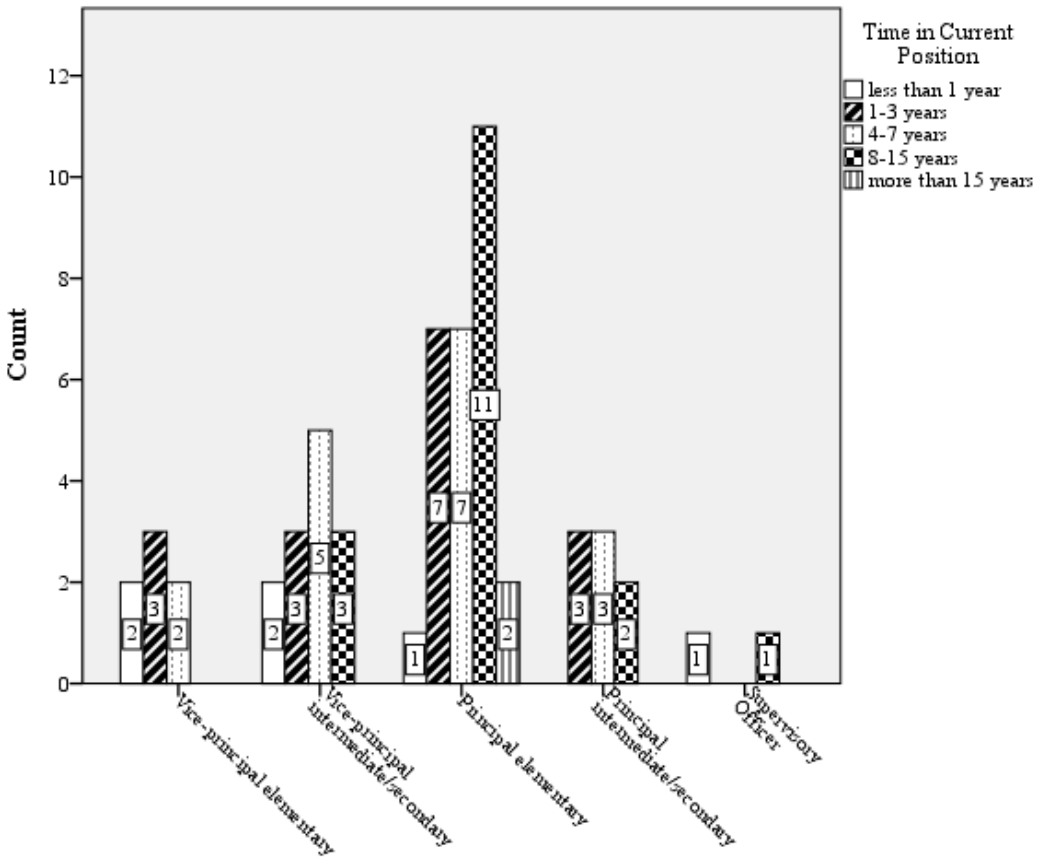

Figure 7. Position Held and Time in Current Position

The student enrolment in the respondents' schools is shown in Table 8. The negative correlation between student enrolment in early grades on individual academic achievement was documented by Krueger and Whitmore (2001). Little can be said about these numbers on their own, unless they are compared with overall equivalent percentages for 2015-2016 public enrolment figures for the two school districts surveyed, which is presented in Table 9 (Queen's Printer for Ontario, 2018). The 2 responses of 'non-applicable' in Table 8 did not reflect missing values. The two supervisory officers with an educator background in the sample do not have a single assigned school.

Table 8

School Enrolment from Sample (respondents)

	Frequency	Percent	Cumulative Percent
less than 200 students	6	10.3	10.3
200-450 students	19	32.8	43.1
450-800 students	15	25.9	69.0
more than 800 students	16	27.6	96.6
N/A	2	3.4	100.0
Total	58	100.0	

Table 9

School Enrolment in Population (schools)

	Frequency	Percent	Cumulative Percent
less than 200 students	29	24.4	24.4
200-450 students	54	45.4	69.7
450-800	26	21.8	91.6
more than 800 students	10	8.4	100.0
N/A	0	0.0	100.0
Total	119	100.0	

Respondents from schools of more than 800 students are overrepresented in percentage of the sample, when compared again in percentage with all the schools from the two school districts. At the other end of the spectrum, the smallest schools represent less than half what would be expected in terms of the percentage of respondents. Therefore, interpretation of these results is speculative. One possible explanation is inspired by anecdotal remarks noted during one-on-one interviews. Knowledge of individual students' performance becomes more challenging as the student body increases in number. Therefore, educators with leadership positions in the largest schools may have had a greater capacity to gather the potential benefits for students brought by analytics and participated in the survey (Moffett & McAdam, 2006).

The data can also be presented in two additional arrangements, shown below, for a thorough look at the data collected. Information on school enrolment in respondents' school can be viewed from the angle of the position held by these respondents, as illustrated in Table 10.

Table 10

Position Held and School Enrolment

	School Enrolment					
	less than 200 students	200-450 students	450-800 students	more than 800 students	N/A	Total
Vice-principal elementary	0	4	3	0	0	7
Vice-principal intermediate/secondary	0	0	3	10	0	13
Principal elementary	6	15	7	0	0	28
Principal intermediate/secondary	0	0	2	6	0	8
Supervisory Officer	0	0	0	0	2	2
Total	6	19	15	16	2	58

Table 11 considers the school size and experience of the survey participants.

Table 11

Student Enrolment and Respondent's Experience

	Time in Current Position					
	less than 1 year	1-3 years	4-7 years	8-15 years	more than 15 years	Total
less than 200 students	1	2	2	1	0	6
200-450 students	1	5	6	5	2	19
450-800 students	2	4	2	7	0	15
more than 800 students	1	5	7	3	0	16
N/A	1	0	0	1	0	2
Total	6	16	17	17	2	58

Neither Table 10, nor Table 11 offers obvious insights that are useful for this study. A different research project might hypothesise that more experienced staff would

be found in larger schools. The sample collected is both insufficient to provide insight for such an assumption and the survey targeted a different set of research questions. Therefore, the analysis on Table 10 and Table 11 will not proceed further.

After examining various combinations around the position held, the investigation turned to the familiarity of survey participants with various analytics tools. Wisdom et al. (2014) saw familiarity as playing a role in innovation adoption at both the pre-adoption and adoption stages. Consequently, this question was added to the survey on the recommendation of the internal research committee of the large school district. The main purpose of this question was to provide telling examples of analytics, providing indications to the research committee of the larger district about the success of their own communication efforts in relation to analytics. The responses on the familiarity of respondents with a number of analytics tools, common in a school setting, are summarized in Table 12 as a frequency distribution of possible answers across the 7 analytics tools of interest. A graph from the same information is proposed as Figure 8.

Table 12

Familiarity with Analytics Tools

	I am familiar with this tool	I am not familiar with this tool	I am not sure
Dashboards (Dreambox, RazKids)	46	10	2
e-Compass for Success	7	44	7
EQAO Data Tool	57	0	1
Excel - KPI Charts	19	35	4
IBM Watson	4	51	3
Ministry of Education: Board Interface Tools	21	23	14
Other tools	8	9	41
Total	162	172	72

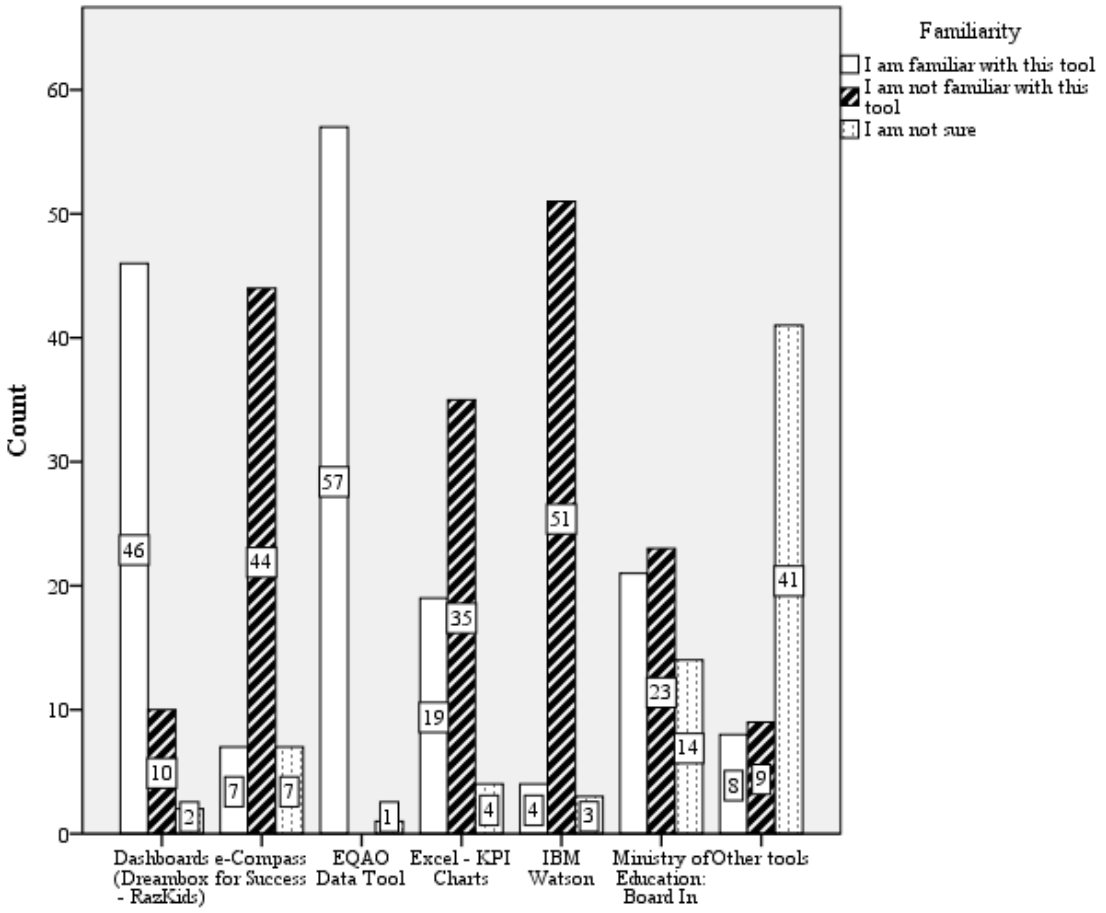

Figure 8. Responses on Familiarity for Various Analytics Tools

A total of 172 responses indicated no familiarity across all analytics tools proposed in Figure 8. Seventy-two responses declared respondents were unsure of their familiarity with one or more of the named tools. One hundred and sixty-two responses expressed some familiarity with at least one tool in the list. These numbers correspond to an average of only 40 percent of responses, showing a clear familiarity with one of the analytics tools suggested. As a facilitator, or barrier during the stages of pre-adoption and adoption noted by Wisdom, Chor, Hoagwood, and Horwitz (2014), such a low level of familiarity slows adoption of analytics tools. When considering the positive bias in interest towards analytics shown by participants in participating in the first place, the real

percentage of actual adopters of analytics tools is likely lower or equal to the 40 percent of respondents somewhat familiar with analytics tools. The S-Curve of adoption discussed by Rogers (2003) still considers newer adopters, those at levels of adoption of an innovation between 13.5 and 50 percent, as early adopters.

The most familiar tool, the EQAO data tool, is supported by an agency of the Ontario government. This tool was familiar to all but one respondent, who was likely confused by the question, or was a reluctant technology user. As will be discussed in the qualitative analysis, the role of principal comes with the expectation of usage of this tool. However, this nearly unanimous expression of familiarity on this one tool may well have distorted perceptions, and therefore responses, on use.

Dreambox and RazKids, dashboards attached to tutorial aids and commercial products, were the second most familiar analytics tools. These analytics tools are provided as part of a paid service, and are accessible via a Web interface, with the data held by the application provider. Private or collaborative ventures, IBM Watson and e-Compass, were the two tools with the lowest awareness among respondents. Those tools require both some non-trivial in-house technical expertise and have an additional cost attached. Exposure to analytics tools appears to be primarily connected to tools where analytics functionality was bundled as part of a package.

Frequency of use of an innovation was the next variable analysed. Along with duration and intensity of use, the frequency of use of an innovation was also identified by Venkatesh, Thong and Xu (2016) as an example of a possible extension to UTAUT. The inclusion of new endogenous variables was considered as enriching the study around mechanisms of adoption. This study had to find a balance between participation and

simplicity to earn acceptance from the larger school district's internal office. Primacy was given to acceptance. Therefore, questions relative to duration and intensity of use were not included in the survey. As it unfolded, the following two questions of frequency of use and mandatory use of analytics were included at the express request of the school district researchers.

Table 13

Frequency of Use of Analytics Tools

	Frequency	Percent	Cumulative Percent
I do not use any of the tools listed above	1	1.7	1.7
I use the tools once a year.	4	6.9	8.6
I use the tools twice a year.	18	31.0	39.7
I use the tools once a month.	24	41.4	81.0
I use the tools once a week.	6	10.3	91.4
I use the tools everyday.	5	8.6	100.0
Total	58	100.0	

The reported frequency of use found in Table 13 corresponds to the minimal expectations indicated in the one-on-one interviews. In order to identify issues early, principals are encouraged to run student at-risk or absenteeism reports, considered as analytics by the large school board as often as possible. Once a month or more is recommended. The dashboards on tutorial aids would be accessed twice or more a year to ensure the packages are used by teachers in the classroom. Usage figures help justify funding for the on-going use and availability of the aids in future school years. The EQAO data tool must be accessed at least once a year during the preparation and discussion of the yearly school improvement plan. The addition of information on the specific tool used and frequency would have provided more actionable information to the larger school board. Those additions would have also lengthened the time required to

complete the survey and discouraged participation. Fortunately, this degree of detail in the information collected was not requested by the main school district.

However, the inclusion of the mandatory use of analytics in the survey at the request of the larger district was a positive development for the application of the UTAUT theoretical framework. When used to represent a proxy variable for the voluntariness of use, the presence of this variable takes a step in addressing a gap expressed by Venkatesh, Brown, Maruping, and Bala (2008) on the understanding of the determinants of behavioral expectation. In a later article, Maruping, Bala, Venkatesh, and Brown (2017) found strong support among practitioners in favour of introducing a construct measuring behavioural expectation (BE) alongside behavioural intention BI.

Viewed as either voluntariness of use or behavioural expectation, only 1 in 4 respondents saw a need to make analytics mandatory. The perception of an almost universal use of analytics would confirm the predominant position as opposed to mandatory use. A different view was taken by Howard, Restrepo, and Chang (2017). They suggested that removing choice, by making use mandatory, would demand a substitution of behavioural intention with attitude in the UTAUT model. Attitude had previously been rejected by Venkatesh et al. (2003) for not having an influence on BI, a position confirmed by Howard et al. However, attitude, defined as positive or negative feelings towards the innovation, was not measured in the survey. Table 14 gives a frequency distribution of the respondents' opinion on the question of mandatory use of analytics.

Table 14

School Board Should Mandate Use of Analytics

	Frequency	Percent	Cumulative Percent
Strongly Disagree	5	8.6	8.6
Disagree	9	15.5	24.1
Neutral	31	53.4	77.6
Agree	12	20.7	98.3
Strongly Agree	1	1.7	100.0
Total	58	100.0	

An interpretation based on frequencies shows that the median and mode response is a neutral position regarding making the use of analytics mandatory. Reinders, Frambach and Kleijnen (2015) attributed mandatory use of technology as engendering negative feelings towards the technology itself. Staff affected would experience a sense of loss of freedom, as well as a greater impression of being manipulated. A predominantly neutral answer avoids getting into a conflict over a function recognised as integral to the role of all educators, promoting the success of students in their care. Under these conditions, distinct measurements discriminating between voluntariness of use and behavioural expectations, as advocated by Maruping et al. (2017), seemed next to impossible. Interviews revealed stronger feelings on the methods and practicality of solutions offered, rather than the principle of analytics.

This closes the discussion on demographic variables data. Aside from a low participation from supervisory officers, demographic data from the survey data demonstrates a close resemblance to the characteristics of targeted individuals working in the two participating school districts, as well as to provincial averages when available. Bundled dashboards and EQAO supplied analytics data were the only tools familiar to almost all respondents. Analytics tools were accessed once a month or less by 80 percent

of users in the sample. Perhaps not a coincidence, only 20 percent of polled individuals were favourable to a mandatory use of analytics. The next section discusses observed variables used to define unobservable latent variables or constructs in the theoretical model.

Manifest variables used to define latent variables. Abdi (2010) reported that the regression technique known as *partial least squares* (PLS), performed later in this document, was referred to with increased frequency as *projection on latent structures*. While the PLS abbreviation remains the same in both cases, the alternate name helps clarify the use of latent variables, which are not directly observable. While the concept of projection will be addressed at a later point, results on the component variables of five latent structures, captured by the survey, will now be discussed. The latent structures involved are performance expectancy (PE), effort expectancy (EE), social influence or norms (SN), facilitating conditions (FC), and behavioural intention (BI).

As established in Table 5, the UTAUT model used in this study considers PE through 4 items or dimensions, each with their own indicator. These manifest variables take the form of the questions and frequency distribution shown in Figure 9. The most common answer across all 4 questions was ‘agree’. Answers to ‘agree’ and ‘strongly agree’ represented over half of the responses. Such results confirmed that a majority of participants believed using analytics would produce gains in job performance and therefore affect BI. Subject to its own limitations, the study by Howard et al. (2017) also disagreed with this tenet of UTAUT by rejecting a relationship between PE and BI. However, the reason postulated by Howard et al. for the absence of a relationship would not hold for the study. A majority of participants in this study saw a clear benefit in their

work activities from analytics. A relationship between PE and BI was expected during the inferential analysis. The number of neutral answers hints at a potential problem with the adoption of analytics as a number of respondents felt that analytics was not saving them time, or increasing their productivity. These issues need to be addressed if adoption is to progress.

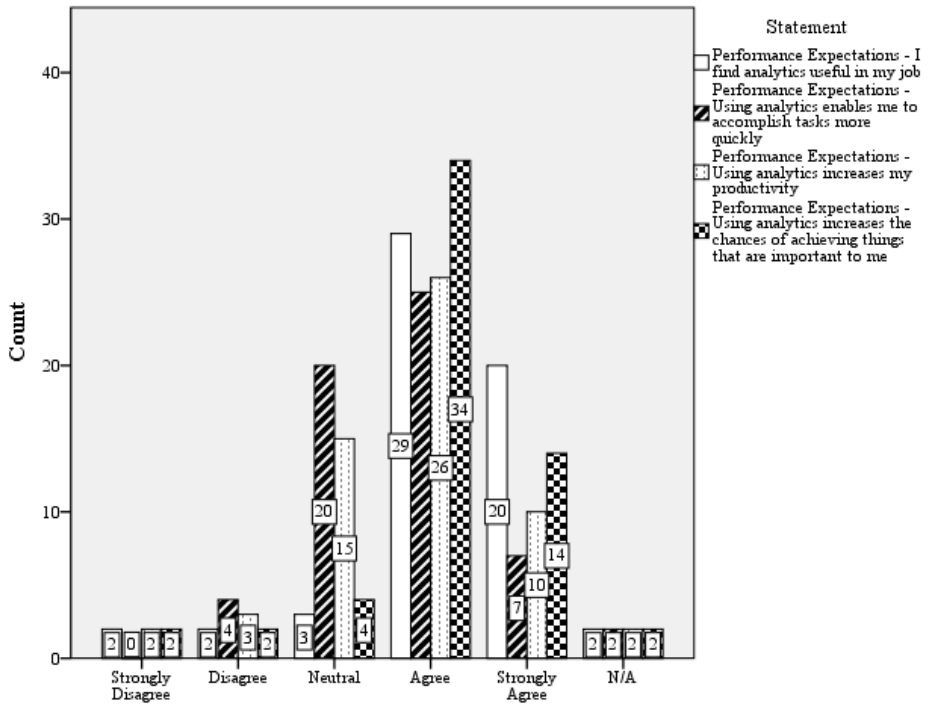

Figure 9. Performance Expectations

A pattern somewhat similar to PE was seen for EE in Figure 10. The pattern was different where it concerned answers of neutral. Answers to EE questions were more definitive in not having an opinion verging to the middle and left of the scale. The results underlined the importance given to root constructs borrowed from Davis' Perceived Ease of Use in TAM (Venkatesh et al., 2003). The greater proportion of respondents in agreement or strong agreement might suggest a greater consensus on the relevance of EE, when compared with PE, and a greater impact of EE on BI. In terms of statistics, the

variance of BI would be expected to find more explanation from EE than from PE with a higher numerical value for the path coefficient.

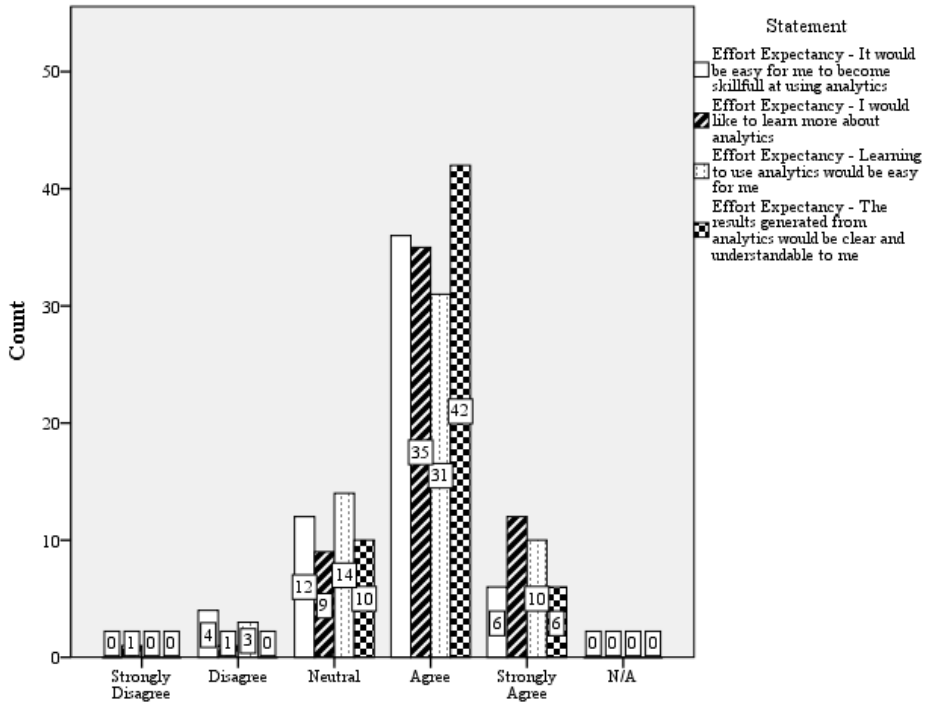

Figure 10. Effort Expectancy

Answers in agreement dominated SN as seen in Figure 11. As was the case for PE, neutral answers were noticeable by their number in SN. This was especially true when individuals close to the respondents were concerned. Expectations and support towards the use of analytics in the work activities of respondents come from a supervisor and less from peers. Members in the social circle of some respondents, whatever their own convictions, expressed less open support for analytics in accordance with the rejection of subjective norm by Davis, Bagozzi, and Warshaw (1989). Although reversed, the expectation for the inferential analysis, derived from the larger number of neutral answers, aligns with those on EE. In the case of SN, the influence would be less than for EE and in line with that of PE.

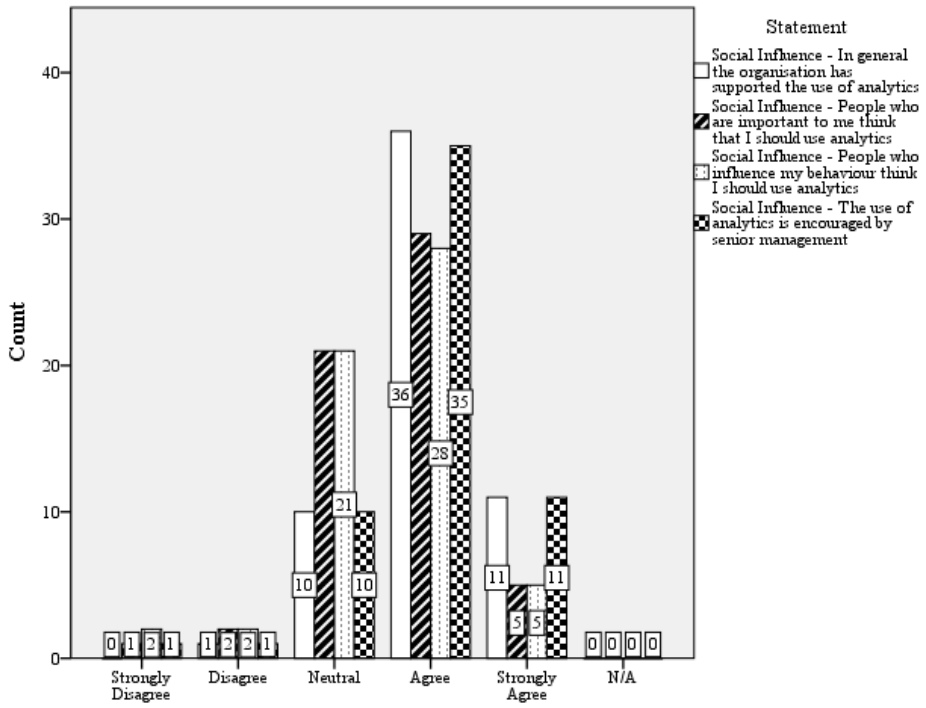

Figure 11. Social Influence

A closer look at the formulation of one question is in order before commenting on FC in Figure 12. While answers of 'disagree' were given more than for previous latent variables, the question on the left uses a negative form to conform to the theoretical framework used by Venkatesh et al. (2003) and their hypothesis as to the absence of impact from FC on BI. Assuming respondents read the question carefully, the majority of respondents were in fact agreeing or neutral that analytics, as presented to them, was compatible with other systems familiar to them. Whereas a quick glance would hint at a problem, the reality is more positive until the number of 'strongly agree answers' are considered. These answers, excluding the negative form question, are the lowest in frequency encountered thus far. The data suggest efforts are needed to improve FC and perhaps the definition of the FC construct.

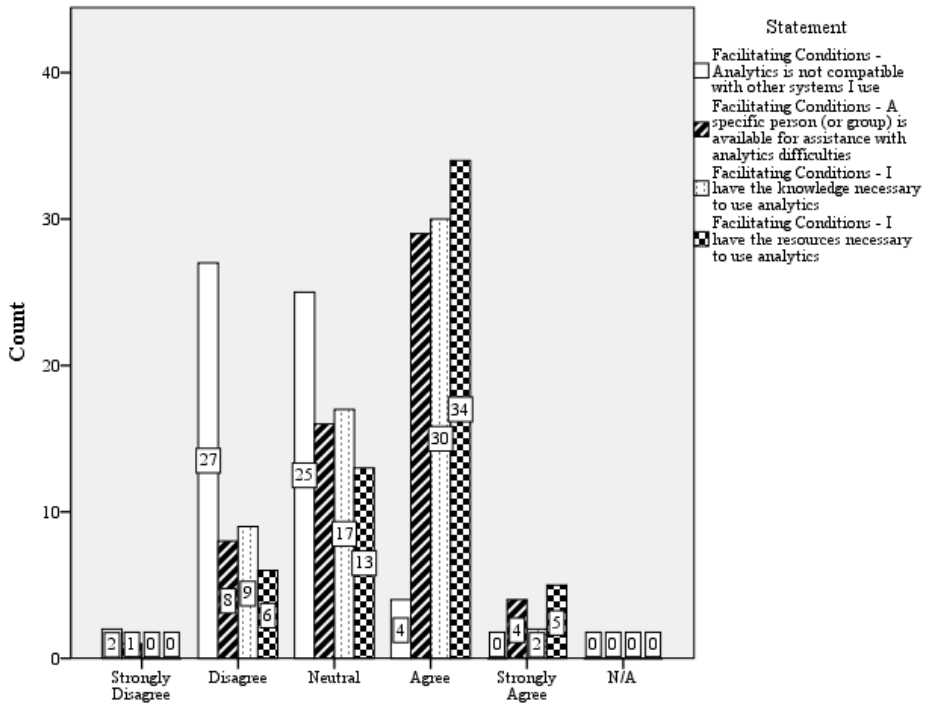

Figure 12. Facilitating Conditions

The obvious feature of Figure 13 on BI concerned unequivocal intentions regarding the daily use of analytics by the respondents. Analytics was not considered as part of a daily routine. The four responses indicating a strong disagreement and aversion towards any use of analytics, came from two secondary vice-principals. Both of these participants had over 8 years of experience in their role and, while one was reaching the end of a regular career age-wise, the second individual would likely have at least another five years in that role. Generally negative answers across all survey questions suggests these non-adopters belong to the category referred in literature as 'active resistance' (Kondra & Hurst, 2009). Although these responses concerned 4 percent of participants in this survey, Kahma and Matchoss (2017) promoted further investigation on the deeper reasons behind non-adoption. Aside from active resistance, non-adoption could be from the undifferentiated 16 percent of laggards (E. M. Rogers, 2003), or be tied to

disenchantment or disinterest. Once the causes are identified, different strategies could be adapted to address each cause of non-adoption (Reinhardt, Hietschold, & Gurtner, 2017). First among the strategies would be information to combat ignorance of the innovation. According to their answers on the familiarity questions, ignorance was an unsurmountable barrier for these two individuals. The discussion around the interviews may help shed some light on this issue. One explanation provided by an interviewee, concerned the amount of work, the focus of the work, and the ease, or rather lack of ease, of getting at useful data.

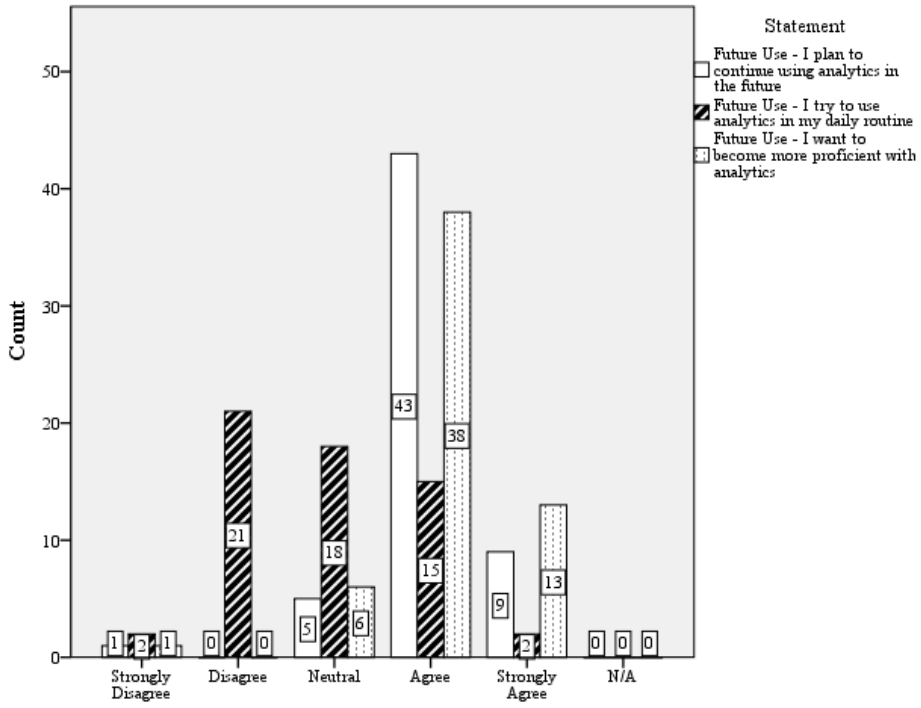

Figure 13. Future Use

In closing, the discussion on the latent variables was kept short on purpose and data on these was meant for processing as part of the inferential analysis. Elements of the descriptive analysis discussion worth remembering are a close match along various demographics of the sample with the population and that analytics tools familiar to

survey participants were integrated into existing applications or used in the preparation of documents.

The inferential analysis described in the next section will present the result of processing the survey data using a regression analysis.

Inferential Analysis. The inferential analysis evaluated indirect and direct effects of latent variables (PE, EE, SN, FC, BI) on the adoption of analytics (USE) in the Ontario school districts surveyed under three key perspectives: strategy; size of the school district; and, student enrolment. In considering Figure 5 and the research questions, the analysis studied four factors seen in the UTAUT model related to gender, age, experience and willingness to use, as well as student enrolment. The hypotheses retained for this study were:

H_1: PE, EE, SN, FC, and BI support a statistically significant relationship with a school administrator's adoption of analytics.

H_2: Age supports a statistically significant relationship with a school administrator's adoption of analytics.

H_3: Experience supports a statistically significant relationship with a school administrator's adoption of analytics.

H_4: Gender supports a statistically significant relationship with a school administrator's adoption of analytics.

H_5: Willingness to use the innovation supports a statistically significant relationship with a school administrator's adoption of analytics.

H_6: Size of the student enrolment supports a statistically significant relationship with a school administrator's adoption of analytics.

Hair, Ringle, and Sarstedt (2011) suggested a formal procedure for the estimation of a partial least squares model. Their recommendations were followed in this study. The inferential analysis begins by establishing the pertinence of using PLS-SEM as the statistical instrument to evaluate the model. The structural model is considered next. The discussion is then expanded to the indicator variables in describing the measurement model. The results of the model estimation are viewed from the angles of the reflective and the formative measurement models, as well as from the structural model. The analysis concludes with the introduction of a revised model and an interpretation of the results and conclusions being drawn.

The choice of PLS-SEM. One challenge for this study was the availability of literature on the subject. The rarity and apparent absence of extant literature on the topic of technology adoption where analytics is concerned in Ontario school boards necessitated an exploratory approach. Another challenge faced in the preparatory stages of this study concerned the difficulty in obtaining data. As a result, the small sample size of 58 responses further constrained the choice of a suitable analysis technique. This study attempted to break new ground and needed a form of structural equation modelling (SEM) to investigate unobserved variables believed to be a composite of measurable quantities.

In venturing into a seldom, or never, explored field of investigation, the choice of a second-generation multivariate method, according to Hair, Ringle, and Sarstedt (2012), as well as Hair et al. (2016), was appropriate. Hair et al. (2011) identified two such second-generation methods, covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM) path modelling. A comparison of the key characteristics of each

technique, shown in Table 15, indicated PLS-SEM as the most suitable. Two similarly named PLS-SEM techniques, consistent PLS-SEM or PLS-SEM regression, each having their own different purposes, were not retained for this study and should not be confused with PLS-SEM path modelling.

Table 15

Decision factors between CB-SEM and PLS-SEM

	CB-SEM	PLS-SEM
Best for	Confirmatory	Exploratory
Sample size	Large (at least 100)	40 or higher
Normality	Assumed	Not required
Significance tests	Parametric	Non-parametric
Focus	Covariance	Variance
Single-item construct(s)	Identification & convergence problems Avoid	Fine

The selection of PLS-SEM path modelling directed the choice of software tool to SmartPLS software (Ringle, Wende, & Becker, 2015), as it was the most comprehensive option available and had received regular updates, up to version 3 at the time of this study.

Structural model. The structural model for UTAUT proposed by Venkatesh et al. (2003) , presented in Figure 5, expects use behavior of an innovation to be affected by a number of indirectly estimated variables . These are latent variables and form a construct made of multiple indicator variables. Examples of latent variables are performance expectancy (PE) or behavioural intention (BI). Gender or age are observable variables, acting as moderators on use behaviour (USE). Following a parsimonious approach, the structural model estimated appears in Figure 14 as the inner dotted box and corresponds to the one found in Figure 5.

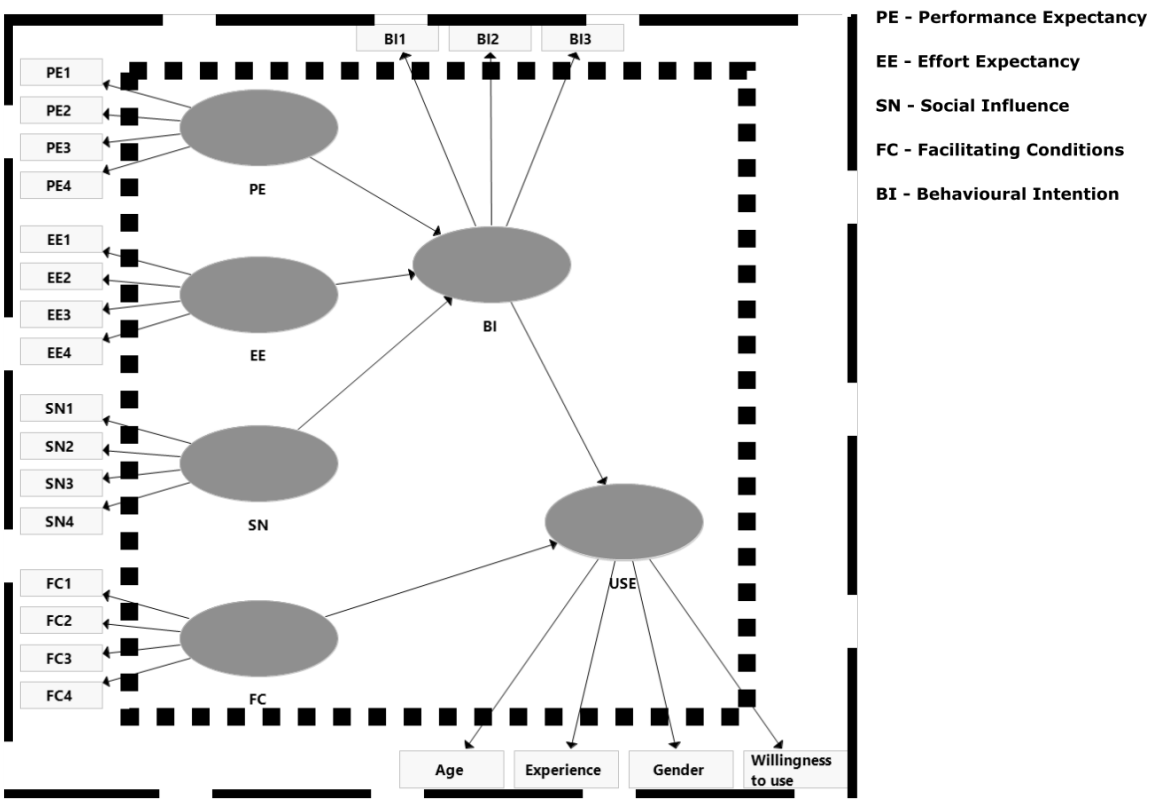

Figure 14. Structural and Measurement Model Estimated under PLS-SEM

Measurement model. One constraint of PLS-SEM is the restriction of indicator variables to a relationship with a single construct. Therefore, the measurement model, found in Figure 14 as the outer dashed box, differs from Figure 5 in that age, experience, gender and willingness to use are assumed for the study to be formative measurements, with a predictive relationship or causal link on future use. Measures of other indicator variables such as PE1 or FC1 are viewed as reflective, helping to explain the variance of the construct to which they belong. These indicators are the values of answers to the survey questions.

Results of the model estimation. The SmartPLS software ran estimations under recommended default settings. The path weighting scheme allowed up to 300 iterations and the stop criterion set to 10^{-7} with no weighting vector. The Lohmöller setting for

initialization option was not selected, to avoid reporting unexpected outer weights reversal. The PLS-SEM algorithm on this first estimation converged after 14 iterations.

Retaining the best indicator variables. A reflective measurement assessment was conducted according to the procedure described by Hair, Hult, Ringle, and Sarstedt (2016). The values for the outer loadings; composite reliability, Cronbach's Alpha, Average Variance Extracted (AVE), and discriminant validity - appear in Table 16. The practice of using Cronbach's Alpha as a measure of internal consistency has been a matter of discussion (Bentler, 2009; Sijtsma, 2009b). Despite Sijtsma's (2009a) reluctance regarding an overreliance on that coefficient in literature to explain reliability, Sijtsma recognised its generalised usage and acceptance in research involving personality or attitude. Therefore, Cronbach's Alpha was reported in this study, along with a measure of composite reliability.

Convergent validity considered the loadings, the indicator reliability and AVE. The majority of loadings passed this test as they were greater in absolute value than the threshold value of 0.70. When squared theses values became the indicator of reliability, also over 0.50. However, EE1, EE2, EE3, FC2, FC4 and BI2 had loadings which did not demonstrate convergent validity. In a second stage of analysis, the Average Variance Extracted (AVE) confirmed issues with EE and FC. In such cases, the value of the loading determines the remedial action taken. A reflective indicator with a loading lower than 0.40 should be removed from the model, while a decision on removal of loading values over 0.40 and below 0.70 would be based on the impact on internal consistency reliability. The statistical significance of the various indicator variables played no role at this stage.

Table 16

Reflective Measurement Model Assessment

Latent Variable	Indicators	Convergent Validity			Internal Consistency Reliability		Discriminant Validity
		Loadings	Indicator Reliability	AVE	Composite Reliability	Cronbach's Alpha	
		>0.70	>0.50	>0.50	0.60-0.90	0.60-0.90	HTMT confidence interval does not include 1
PE	PE1	0.842	0.792	0.837	0.954	0.936	YES
	PE2	0.866	0.858				
	PE3	0.823	0.828				
	PE4	0.778	0.869				
EE	EE1	0.366	0.134	0.387	0.693	0.677	YES
	EE2	0.621	0.386				
	EE3	0.465	0.216				
	EE4	0.902	0.813				
SN	SN1	0.842	0.709	0.685	0.897	0.847	YES
	SN2	0.866	0.749				
	SN3	0.823	0.677				
	SN4	0.778	0.606				
FC	FC1	-0.727	0.528	0.427	0.263	0.324	YES
	FC2	-0.471	0.222				
	FC3	0.823	0.677				
	FC4	-0.530	0.280				
BI	BI1	0.869	0.756	0.631	0.835	0.710	YES
	BI2	0.663	0.440				
	BI3	0.835	0.698				

According to these rules, EE1 was the only indicator which the rules indicated should be removed without further hesitation. Therefore, the step of removing EE1 as an indicator variable was taken as part of the analysis. Table 17 presents the results of different exclusion scenarios. The complete tables can be found in Appendix J.

The exclusion of EE2 and EE3 needed to be evaluated separately. Removing EE1, EE2 and EE3 meant EE would become a single-item measure consisting only of EE4. Although single-item measures are supported by PLS-SEM, their negative impact on predictive validity detracts from their appeal, due to their simplicity and deceitful

measures of high validity and reliability. Nonetheless, the single-item case for EE was tested first. That option offered no overall benefit to the model.

In combination with the removal of EE1, estimations were conducted with the separate removals of EE2 and EE3. As a measure of reliability, Cronbach's Alpha was each time lower than with the full model or with only EE1 removed. Reliability with AVE was above the threshold with both EE2 or EE3 removed. However, Cronbach's Alpha reached its lowest values with the removal of either EE2 or EE3. A compromise appeared possible by excluding only EE1 from EE. Although Cronbach's Alpha was lower than the threshold, it was at its highest once EE1 was removed. Therefore, only EE1 was removed from the model.

Table 17

Scenarios regarding EE

Exclusions	Convergent Validity	Internal Consistency Reliability	
	AVE	Composite Reliability	Cronbach's Alpha
	>0.50	0.60-0.90	0.60-0.90
None	0.387	0.693	0.677
EE1	0.468	0.709	0.579
EE1 and EE2	0.535	0.648	0.246
EE1 and EE3	0.600	0.737	0.405
EE1, EE2, EE3	1.000	1.000	1.000

The same procedure was followed for FC2 and FC4, as seen in Table 18. Validity, as measured by AVE, would be no worse by excluding indicators from FC, and even improved in some instances. However, the reliability of the construct was much degraded. Cronbach's Alpha turned negative when both indicators were removed. A note from Cronbach and Hartmann (1954) anticipated the possibility of a negative alpha coefficient in certain situations and offered their interpretation of such an occurrence. Cho and Kim (2015) described two such situations. The first case involved an improperly

coded item to account for the reversal in meaning, involving a negatively worded question, as opposed to one or more other questions evaluated at the same time. In the second situation, the explanation for a negative coefficient pointed to a negative discrimination among items surveyed, indicating that respondents had no real understanding of what was being asked. Alone in that group of questions, Question 8.3 "Analytics is not compatible with other systems I use" in the survey adopted a negative formulation in accordance with the UTAUT model and could not be reverse coded to conform with the progression of the Likert-scale used in the three other survey questions around FC. In mathematical terms, that indicator showed a negative correlation with all other indicators in that group, thereby affecting the calculation of the Cronbach's Alpha coefficient. The decision to keep FC2 and FC4 as part of the model allowed for a less scattered latent variable estimation, promoting reliability at the expense of some validity. The reverse in prioritising between reliability and validity would prove impossible to operationalise.

Table 18

Scenarios regarding FC

Exclusions	Convergent Validity	Internal Consistency Reliability	
	AVE	Composite Reliability	Cronbach's Alpha
	>0.50	0.60-0.90	0.60-0.90
None	0.427	0.263	0.324
FC2	0.506	0.068	0.045
FC4	0.483	0.040	0.023
FC2 and FC4	0.427	0.139	-1.023

BI2 showed signs of requiring the same analysis. In that case, the impact of the removal of BI2 on reliability was negligible. However, as shown in Table 19, validity improved by a small measure and remained above the minimum threshold. Through the exclusion of BI2, the measurement would, in statistical terms, become closer to its actual

value and remain as concentrated around that value as with BI2 in the model. On that basis, BI2 was excluded from the model for improved validity and no decrease on reliability. The measurement model became the same as shown in Figure 14 with the EE1 and BI2 indicator variables removed.

Table 19

Scenarios regarding BI

Exclusions	Convergent Validity	Internal Consistency Reliability	
	AVE	Composite Reliability	Cronbach's Alpha
	>0.50	0.60-0.90	0.60-0.90
None	0.631	0.835	0.710
BI2	0.776	0.874	0.711

The reflective measurement model assessment closed with two fewer indicator variables, EE1 and BI2. The assumption of a formative relationship between USE and four indicator variables based on theoretical reasons should still be tested, and rejected, if warranted by the assessment of the formative measurement model.

Formative measurement. Hair, Hollingsworth, Randolph, and Chong (2017) suggested a confirmatory tetrad analysis (CTA) to avoid incorrect specification of indicators. CTA tests and evaluates both the relationships between latent variables and the specification of indicator variables (Bollen & Ting, 2000). One caveat of CTA did not apply in the case of the sample for this study. CTA tends to support a reflective model with larger sample sizes. The small sample size of 58 responses in this study would not have affected the validity of CTA. Where CTA is concerned, Venkatesh et al. (2003) already established the relationship between latent variables in the UTAUT model. The statistical significance of proposing one formative measure, with the latent variable USE in the model, remained to be evaluated.

The CTA technique requires a minimum of 4 indicators per latent variable in order to examine covariances in groups of four and determine if tetrads vanish by reaching a value of 0. Vanishing tetrads support the null hypothesis of a reflective measurement. USE had the requisite 4 indicators, namely age, experience, gender, and willingness to use. The measurement model for the PLS-CTA procedure appears in Figure 15. The test confirmed the tetrad vanished with 0 within the adjusted confidence interval and supported a reflective, over a formative, specification through the failure in rejecting the null hypothesis.

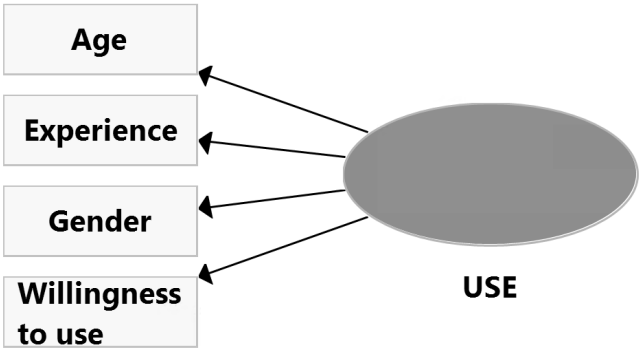

Figure 15. Confirmatory Tetrad Analysis on USE

The assumption made by the researcher in this study, of a formative measurement for the USE latent variable, was not supported by a confirmatory tetrad analysis. Therefore, the model estimated was corrected to be reflective on all indicator variables. An assessment of formative measurement model was made unnecessary by the absence of any formative relationship. Having confirmed the reliability and validity of the constructs, the analysis could proceed with a discussion of the structural model.

Structural model. The assessment of the structural model followed 6 steps. For the first step, analysis was conducted to determine if any collinearity issues might have existed in the model, as estimated by the survey data collected. In the second step, the

significance and relevance of the relationships in the structural model were assessed. The third through sixth steps assessed the level of R^2, the f^2 effect size, the predictive relevance (Q^2) and the q^2 effect size. Figure 16 shows the estimation confirmed to converge after 12 iterations with R^2 coefficients for endogenous variable BI and USE. With some margin, the appearance of the lower R^2 of 0.312 was higher than the minimum discernable, with a sample size of 58 final responses. The programme G*Power estimated a smaller sample size of 54 would allow the detection of R^2 values of around 0.25 (American Statistical Association, 2017).

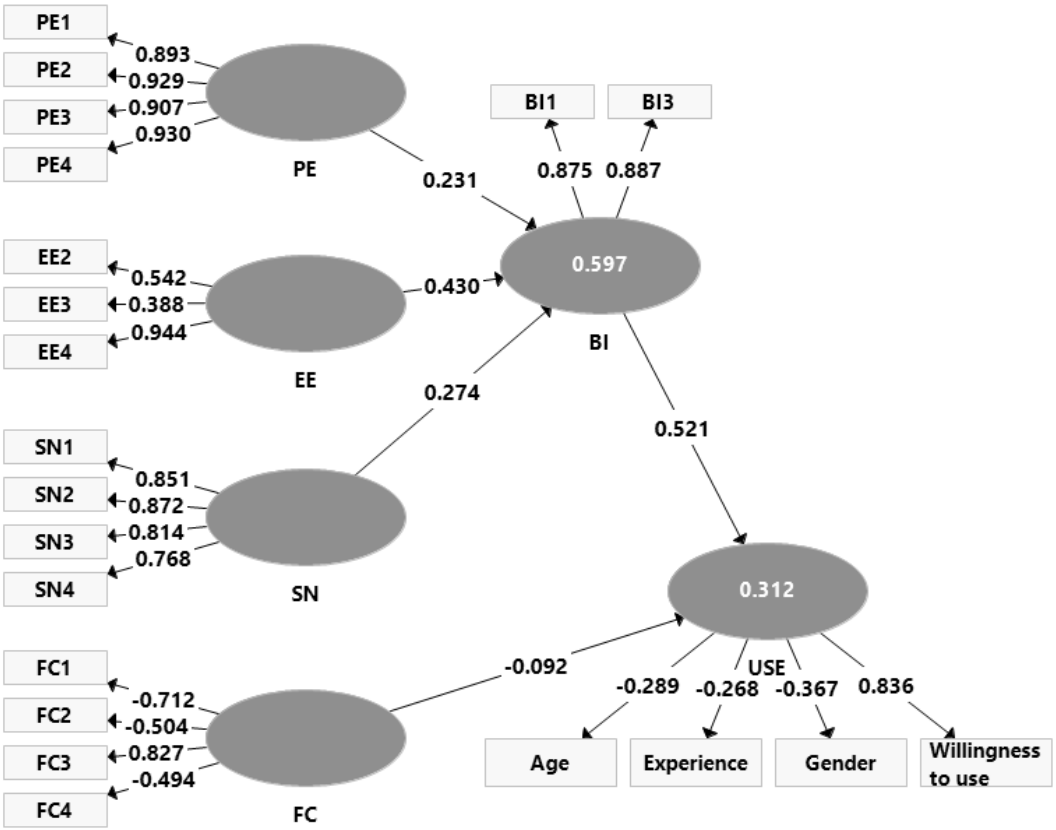

Figure 16. Final Structural Model Estimation

Assessing collinearity is required with multiple regression techniques, including the PLS-SEM algorithm. This is done to avoid bias in the estimation of path coefficients, should predictor constructs have high collinearity among them. The recommended

criterion to determine if excessive collinearity exists is a variance inflation factor (VIF) value exceeding 5. This estimation returned inner VIF values ranging from 1.134 to 1.526. Consequently, because those values were well below 5, it was determined that collinearity was not an issue in the model.

The relevance and significance of the path coefficients must be viewed in terms of the value of path coefficient and their statistical significance. Path coefficients are, in general, constrained to a range of values from -1 to +1. A path coefficient close to absolute 1 denotes a strong relationship between the connected elements. They also tend to prove to be statistically significant. The sign of the path coefficient serves to indicate the direction of the change in the one element when the other element increases, or decreases, in value. With one exception, the values of the path coefficients were all positive and varied, from a low of 0.231 between PE → BI and a high of 0.521 between BI → USE. Although negative, one exception, joining FC → USE, showed a rather small path coefficient, indicating a somewhat counterintuitive and slight, but not negligible, negative influence of FC on USE, reaching almost 10 percent. With no judgment as to the statistical significance of the result at this point, a negative coefficient in the estimation of this path suggests that an investment in facilitating conditions worked against adoption, and warranted particular caution during the analysis.

As a point of comparison with a model considering attitude at the same time as PE, EE, SN, FC, Howard et al. (2017) obtained a coefficient path of 0.54 for the same relationship. Under conditions closer to this study, Liu & Huang (2015) estimated the same path coefficient at a significant and positive 0.47. Table 20 reveals the path coefficients and total effects in ascending order to USE. In the case of the BI → USE

relationship, Table 20 shows the individual relative contribution of each exogenous variable. Although not very strong at values below 0.25, the strongest influence on BI came from EE, followed by SN, and ending with PE. The total effect of BI on USE was more pronounced. Regardless of the value of any path coefficient, their statistical significance still remains to be established.

Table 20

Path Coefficients and Total Effects

Latent Variable	BI	USE
FC		-0.092
PE	0.231	0.120
SN	0.274	0.143
EE	0.430	0.224
BI		0.521

Traditional tests to establish statistical significance are not suitable in PLS-SEM. The lack of a requirement for normality prevents a parametric student's *t* test and a confidence interval to be derived from an estimation of the model. The bootstrapping technique bypasses that limitation by allowing a large number of model estimations, with an equal number of different bootstrap samples generated from the original sample with replacement (Garson, 2016). Each bootstrap sample contains the same number of bootstrap cases as there are in the original sample.

The default value of 5,000 bootstrap samples was overridden in this instance and lowered arbitrarily to 500 subsamples. The most conservative option of *No Sign Changes* was selected in SmartPLS. The amount of results was set to *Complete Bootstrapping*. The smaller size of the sample allowed for the confidence interval method to be set to *Shi's Double Bootstrap*. The double bootstrap option meant bootstrapping performed intense computations on 250,000 subsample estimations, or 50 times the default 5,000

subsamples. The test type was set to *Two Tailed* and the *Significance Level* remained at 0.05.

The estimation converged after 12 iterations and could be analysed. Bootstrapping provided *t* statistics and *p* values for the outer model shown in Table 21 and revealed that only two relationships, from EE and SN to BI, were significant at a 5% level. In other words, the test failed to reject the null hypothesis only in the case of these two relationships. The FC to USE relationship was particularly problematic with regard to statistical significance. SmartPLS offered further confirmation through the *Confidence Interval Bias Corrected* at 2.5% and 97.5%. Relationships containing the value 0 between the lower and upper bounds were not statistically significant at the 5% level tested.

Table 21

Outer Model t Statistics and p Values

Relationship	*t* Statistic	*p* Value	Significant at 5% level?	Confidence Interval Bias Corrected	
				2.5%	97.5%
PE → BI	1.348	0.178	No	-0.151	0.013
EE → BI	3.400	0.001	Yes	0.243	0.649
SN → BI	2.767	0.006	Yes	0.014	0.375
FC → USE	0.282	0.778	No	-0.094	0.867
BI → USE	1.116	0.265	No	-0.276	0.013

The bootstrapping estimation produced statistical significance information for the inner model. The values of *t* statistics and *p* values for the relationship between the latent variables and their indicator variables are presented as extracted from the outer loadings of the bootstrapping estimation in Table 22. The hints of issues with EE and FC were confirmed here with EE3, but FC1 through FC4 were not significant. Also problematic was the fact that all four indicator variables for USE were not statistically significant. Garson (2016) discussed whether the removal of indicators considered not statistically

significant was appropriate for reflective and formative models. As the model used in this study was determined to be reflective throughout, as per Garson's study, removal of one indicator could take place, provided enough other indicators remained to form the construct. Therefore, EE3 could be removed from EE and the construct continues to exist.

The situation is different if all four constituent indicators in each of FC and USE were removed from the model. The situation with regard to the non-significance of FC was demonstrated by Venkatesh et al. (2003) in the absence of moderators. However, the present study found the moderators of age and experience also had no impact on the significance of FC. FC and USE could, therefore, no longer remain in the model. A single-item construct at least would have to be created in order to assess willingness to use. At this stage, the analysis examined the coefficient of determination (R^2) without any change to the measurement and structural models.

Table 22

Inner Model t Statistics and p Values

Relationship	*t* Statistic	*p* Value	Significant at 5% level?
PE1 ← PE	5.076	0.000	Yes
PE2 ← PE	5.837	0.000	Yes
PE3 ← PE	5.779	0.000	Yes
PE4 ← PE	7.502	0.000	Yes
EE2 ← PE	2.855	0.004	Yes
EE3 ← PE	15.356	0.180	No
EE4 ← PE	4.633	0.000	Yes
SN1 ← PE	11.454	0.000	Yes
SN2 ← PE	15.046	0.000	Yes
SN3 ← PE	4.633	0.000	Yes
SN4 ← PE	6.954	0.000	Yes
FC1 ← PE	1.060	0.290	No
FC2 ← PE	0.951	0.342	No
FC3 ← PE	1.200	0.231	No
FC4 ← PE	0.861	0.390	No
BI1 ← PE	11.398	0.000	Yes
BI3 ← PE	11.555	0.000	Yes
Age← USE	0.756	0.450	No
Experience ← USE	0.711	0.477	No
Gender ← USE	0.815	0.415	No
Willingness to use ← USE	1.119	0.264	No

In PLS-SEM, the coefficient of determination provides a measure of the amount of variance in endogenous constructs BI and USE explained by exogenous constructs PE, EE, SN, FC, and BI. Hair et al. (2011) categorised R^2 values as either substantial, moderate or weak, when around 0.75, 0.50, or 0.25 respectively. Under that rule of thumb, the R^2 values returned by the estimation were moderate to substantial for BI and weak to moderate (0.312) in the case of USE. The relative simplicity of the model estimated made a discussion of R^2 *adjusted* unnecessary. Also, the bias introduced in the coefficient of determination by larger models would not be an issue in this instance. The question of the f^2 effect size was examined next and meant a temporary return to the amended model estimation, rather than the bootstrapping estimation.

The f^2 effect size evaluates the impact on R^2 of omitting a specific exogenous construct. As an example of application of the f^2 effect size, the FC construct was seen earlier as a candidate for removal from the model. The impact of removing that construct from the model would, in the case of FC (0.011), be around 0.02 or below, and would signal a small effect on R^2. As a guideline, f^2 effect size of 0.15 would represent a medium effect, while a value of 0.35 would be considered a large effect. The f^2 effect sizes obtained appear in Table 23. The weakest f^2 effect size concerned USE. The removal of exogenous constructs EE and BI would have had a large effect on their attached endogenous construct R^2 value, while removing SN would have had a medium effect. As for PE, its f^2 effect size was partway between medium and small. The model could be assessed for out-of-sample predictive power with its Q^2 values, by the next assessment to be conducted.

Table 23

f^2 Effect Sizes

Construct	BI	EE	FC	PE	SN	USE
PE	0.087					
EE	0.301					
SN	0.126					
FC						0.011
BI						0.348
USE						

A model demonstrating predictive relevance could be trusted to perform in the same manner with a different sample. Obtaining the Q^2 values of the model meant running another estimation with blindfolding at the minimum recommended omission distance of 5. The sample size of 58, divided by the omission distance of 5, would not return an integer and, therefore, was adequate. Aside from performing a blindfolding

estimation this time, no changes were made to any software settings, compared to previous estimations. Results shown in Table 24 supported the model's predictive relevance with Q^2 values greater than 0 on both BI (0.347) and USE (0.035). The lower value of Q^2 on USE was worth noting. The assessment of the q^2 effect size completed the formal model analysis.

Table 24

Q^2 Values and q^2 Effect Size

Construct	Q^2 Value	q^2 Effect Size	
		BI	USE
PE		0.020	
EE		0.129	
SN		0.044	
FC			-0.323
BI	0.347		0.094
USE	0.035	-0.333	

The purpose of investigating q^2 effect sizes in relation to Q^2 effect sizes can be likened to looking at f^2 effect size together with R^2. The q^2 effect size in Table 24 indicated the relative impact of predictive relevance. Obtaining the q^2 effect sizes required running X number of estimations, removing a different endogenous variable each time. Following the 0.02, 0.15 and 0.35 rule of thumb, the effect size of the various constructs varied from small to almost large, except in two instances for USE in relation to FC and BI, where the values were strongly negative. As was pointed out previously, the lower value of Q^2 on USE affected the calculation of q^2 around that construct. The matter of a negative q^2 effect size remains "a very under-researched field" according to a developer of the SmartPLS software, and was not investigated further (Becker, 2017). Aside from these two negative values, the q^2 effect sizes supported the presence of an

impact on predictive relevance from removing any of the PE, EE, SN or BI constructs from the model. The relevance of keeping FC as part of the model remained questionable.

The previous discussion pointed out some weaknesses in the specification of the structural and measurement model based on UTAUT. In specific terms, the predictive power of the structural model suffered from the inclusion of FC. Given the relevance of other constructs, H_1 found partial support. As for the measurement model, age, experience, gender and willingness to use did not demonstrate their usefulness in helping to predict future use of analytics. H_2, H_3, H_4, H_5 did not find support in the analysis. Therefore, the investigation moved in the direction of specifying a different structural and measurement model which would help test hypothesis H_6 regarding the impact of the size of student enrolment on analytics adoption in Ontario K-12 district school boards, as represented by the two districts surveyed.

Search for a better predictive model. The conceptual flexibility of UTAUT has often seen studies testing modifications to the original model (Venkatesh et al., 2003). For example, Dwivedi, Rana, Jeyaraj, Clement, & Williams (2017) obtained better results than the basic model by mediating PE and EE through a new endogenous variable of attitude, ahead of BI. Quasim and Abu-Shanab (2016) chose to investigate the impact of network externalities by introducing two new exogenous constructs, representing trust and the increased perceived value of the innovation derived from a growing number of adopters. For this study, the six steps above were repeated with a new model specification. Results are presented in Appendix L.

Informed by the previous analysis and in trying to test H_6, the revised model shown in Figure 17 was assessed. The inclusion of the size of the student body in an

estimation would inform on the future relevance of considering this factor in research on the subject and address research question Q4. Guster and Brown (2012) warned of a "bumpy" road for small to medium educational institutions involved in a business intelligence initiative. The differences with the original UTAUT modified by removing poor performers EE1 and BI2 were the removal of FC and the substitution of a single-item construct for USE based on the school enrolment. Although never explained in the text, the absence of FC was a notable and rare feature of a study by Kademeteme et al. (2017). Extant literature sees the concept of firm size present in the TOE framework being used in conjunction with other theoretical models such as TAM (Awa, Ojiabo, & Emecheta, 2015; Gangwar et al., 2015; Mahesh et al., 2018). The researcher only encountered Kademeteme et al. studies as an example of combining UTAUT with the firm size characteristic borrowed from TOE. However, unlike in Kademeteme et al., the study is unique in also removing gender, age and experience from the model, in consideration of the homogeneity of characteristics among leaders in education.

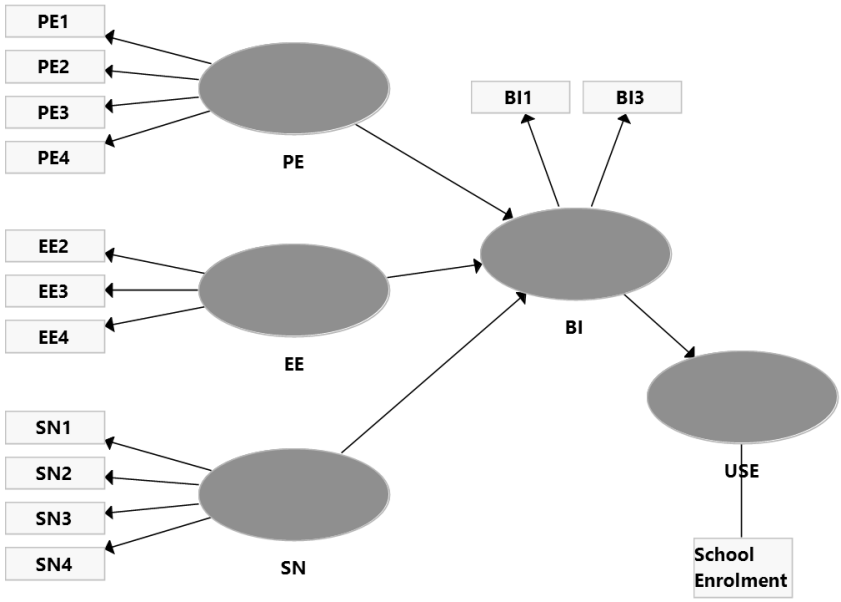

Figure 17. Proposed Revised Predictive Model

As discussed previously, validity and reliability are both relevant goals. However, reliability without validity is unsatisfactory. Despite a low loading on EE3, the best scenario combining the highest AVE above the 0.50 threshold at 0.588, a satisfactory composite reliability of 0.721 and, under those circumstances, the best Cronbach's Alpha (0.405) called for the removal of EE2. Therefore, the revised model was modified to remove EE2. Kademeteme et al. (2017) experimented in similar fashion by removing 2 indicators from PE, or 3 from EE, by having 3 indicators for SN. Noteworthy, and an interesting parallel with the situation encountered with FC in the present study where both SN and FC are expected to have a positive impact on BI, is that Kademeteme et al. had obtained a small negative coefficient on SN. In a major distinction between their model and the one of this study, Kademeteme et al. were forced to remove SN altogether in their final estimation for lack of statistical significance. With no formative relationship in the model, the CTA test was not performed. An estimation of this model produced Figure 18 showing outer loadings between indicator and endogenous variables, the path coefficients and R^2 value of exogenous variables. The low value of R^2 was so close to 0 as to suggest the School Enrolment indicator variable was statistically insignificant.

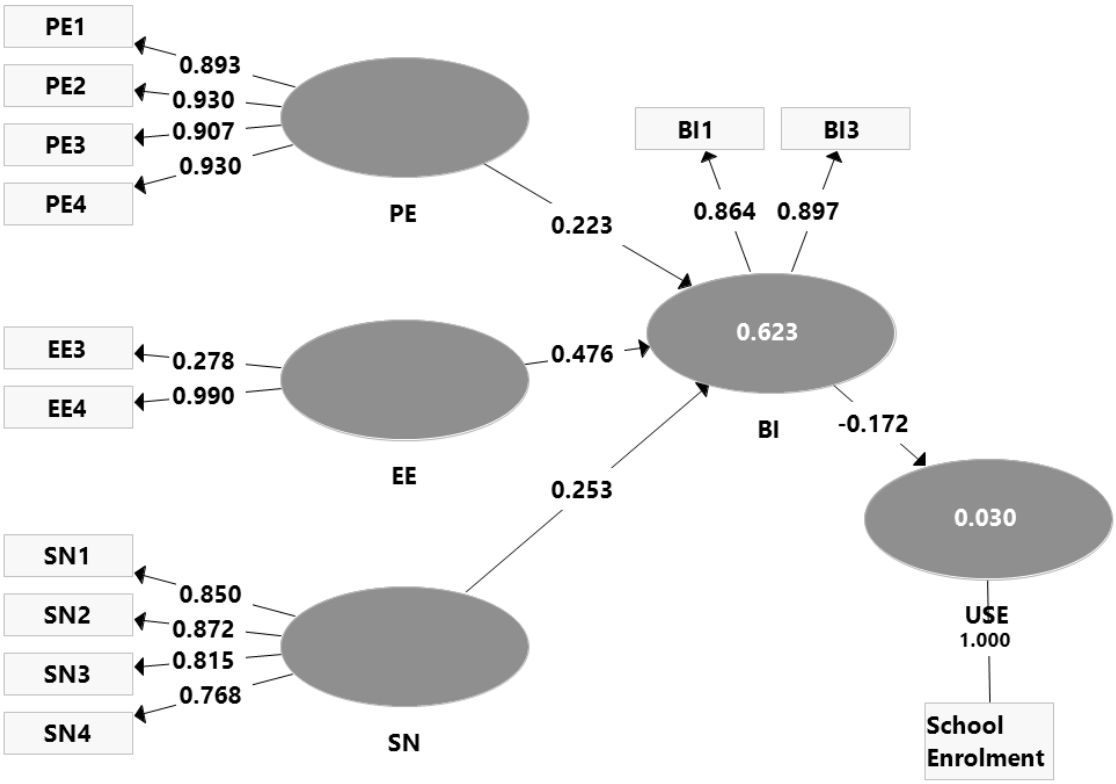

Figure 18. Final Proposed Revised Model

Although path coefficients were either low to medium in their impact on the model, total effects on USE were negative on all latent variables. Subject to establishing the statistical significance of that variable, the use of School Enrolment as a single-item construct had the overall effect of degrading the predictive power of the model. A bootstrapping estimation of the second version of the revised model revealed that from the perspective of both the *p* value and the *confidence interval bias corrected* measures, the test failed to refute the null hypothesis on the path coefficient joining BI to USE. Therefore, H_6 was not supported.

Concluding remarks on the inferential analysis. The proposed revised model did worse than the original UTAUT model at predicting the future use of analytics among senior administrators in Ontario district school boards. The revised model struggled and

ultimately failed in including school enrolment as a significant factor in favour of analytics adoption. Until proven otherwise in subsequent studies, the conclusion was for the original UTAUT model to remain the gold standard in evaluating adoption in the Ontario K-12 domain. All hypotheses, save the first one, could not, in statistical terms, exclude the possibility of the null hypothesis regarding their impact. However, the relevance of PE, EE, SN and BI in this context was supported. The elimination due to their statistical non-significance of FC, as well as moderators for age, gender, and experience present in the basic UTAUT model (Venkatesh et al., 2003), contributed to the originality of the research. The researcher had not seen this particular combination of elements in extant literature, making the study's contribution unique.

Concluding remarks on the quantitative analysis. A flaw in the data collection may have caused issues with the estimation from the start. The near 100% use of analytics as reported was unexpected by the researcher. Therefore, the absence of variability in the data made estimations lose some of their meaning, as well as difficult to perform, given low buy-in from the targeted population across the province of Ontario. A pilot phase on the survey would have been desirable, but near impossible to achieve in the circumstances. Nonetheless, a pilot would have hinted at a need for a different and more discriminant measurement on usage.

Research Findings from Interviews

This section expands on the survey findings by presenting a qualitative analysis of four interviews held with educators in leadership positions. The interview questions appear in Appendix B. Although interviewees all shared a common career path starting as classroom teachers, they each represented a different perspective on the issue and held

different levels of responsibilities in two organisations with distinctive characteristics discussed below. They had previously answered the survey and gained a better understanding of the aim of the study. An information sheet on the research and a copy of the consent form were sent before scheduling any of the interviews. The interview questions were formulated to establish a link with the central themes of strategy, adoption, and enrolment size, in the context of primary and secondary education. As suggested by Irvine, Drew, and Sainsbury (2013), the interviews were conducted face-to-face, and thus provided more complete answers than is typical of interviews conducted over the phone. The interviews were also longer and richer in content than the scheduled 30 minutes. Speaker overlap was minimised through visual cues and more comfortable for interviewer and interviewee. In all cases, interviews took place in the familiar surroundings of the interviewee's office. Although the experience of senior leaders in education in dealing with staff and students made the location less relevant, Herzog (2005) attributed a role to location in constructing reality.

In order to gain the cooperation of potential interviewees, an explicit commitment was made to limit communications to 30 minutes. A further assurance of anonymity was given to participants, as well as a commitment to share access to the final research document and to an executive summary of the research. Following the interview, and to avoid misinterpretation of the interview content by the researcher (Mero-Jaffe, 2011), a transcript was sent to each individual asking if any amendment to the content of their interview should be made. A record of these messages was kept as part of the transcript review approval process, as well as any confirmation message received. No request for amendment to content was received.

This section is broken down in three parts and begins with an overview of the four participants and of their relevance to the research. The second part is subdivided along the three central themes identified. The section is then summarised and concluded in the third and last part.

Overview of the case studies. The school district and the identity of the interviewees were coded in an effort to ensure their privacy. Relevant information on the two districts is presented in Table 25. The difference in scale of the two districts is significant, with almost a ten-fold difference in student enrolment and in total population served. The respective annual budget figures drawn from district documents further highlights the size disparity between both school districts. The ratio of 25 to 1 in population density between Case A and Case B corresponds to an overall geographical area less than half the size of the mostly rural school district. The count of schools reflected administrative establishments and followed the strict definition of school grades from junior kindergarten to 8 belonging to an elementary school, while high schools housed grades 9 to 12. The number of distinct school buildings could be different, where Grades 7 and 8 students in senior elementary, also named intermediate schools, shared a physical location with a high school, as was the case in School District A. For instance, Participant 2 was principal of a combined senior elementary and high school.

Table 25

Profile of case organisations

Case	Rural, Urban or Mix	District Enrolment*	Schools		Annual budget	Population served**	Population Density (per km^2)**
			Elementary	Secondary			
A	Urban with extensive rural area	40,575	81	16	$514 million	934,243	334.8
B	Rural with urban areas	4,571	20	2	$62 million	102,394	13.7

Sources: * 2015-2016 Academic Year (Queen's Printer for Ontario, 2018)

** Population and Dwelling Count Highlight Tables, 2016 Census (Statistics Canada, 2018b)

Four interviews were conducted and Table 26 presents summary information on the single participant from Board B and the three participants from Board A. One representative from each group targeted by the study agreed to be interviewed, namely a chief executive in the person of a director of education, an education superintendent who happened to hold the portfolio responsible for technology in that school district, and two school principals representing the entire range of school grades. This provided a 360-degree representation of the work done around analytics by senior administrators and executives in the two school districts involved in the study.

Table 26

Roles of interviewees

Participant	District	Role in the school district	School Enrolment*
1	A	Principal, Grades Junior Kindergarten to 6	166
2	A	Principal, Grades 7 to12	1,559
3	A	Superintendent of schools (Technology portfolio)	n/a
4	B	Director of Education	n/a

Source: * 2015-2016 Academic Year (Queen's Printer for Ontario, 2018)

The discussion of the first and second cases presents historical and distinctive elements which shaped the current situation regarding analytics in those school districts. The first case discussed concerned the larger district by student enrolment, Case A.

Case A – Urban with extensive rural area. School district A was formed in 1998 through the amalgamation of two predecessor school boards of average size (Maclellan, 2007). Prior to that time, one board encompassed the city core and had a lengthy history of over a century. The other board served the regional periphery and was incorporated in 1969. The two predecessor boards supported education in both official languages until 1989, when a distinct French-language school board was created. Sustained growth in enrollment defined the board serving the periphery of the city, while the centre town board experienced declines in enrolment. The area surrounding the city core continued to see significant housing development from urban sprawl.

As intended by the Fewer School Boards Act of 1997, which sought efficiencies through mergers, the combined organisation doubled in enrolment size and increased the geographic area from where it pooled its students, compared with each of its predecessors (X. Li, 2015). However, two points of concern about that amalgamation, raised by Li, did not apply to the local situation with this school district A. First, the change in structure and scale gave little evidence of creating the distance feared between trustees and constituents in collaborating on continued education improvement under the merged organisation. For example, from the public record, the consolidation of services in the name of efficiency and consistency was made less contentious through communication among stakeholders than that experienced by the coterminous board sharing the same geographical area. In that other board, projects of school closures for less viable schools

faced opposition. The implementation of these projects led to protracted efforts, acrimonious legal actions, and frequent decision reversals. Finally, the weakening of links between boards and schools was enacted on the administrative aspects described by Li. However, the amended decision-making process did not prevent a sustained involvement on the part of the district in school affairs and united, coordinated efforts to promote fairness across the system. While this particular urban school district in a larger service city is sheltered from most economic uncertainties, communities with challenging socio-economic conditions also exist within its jurisdiction area. At last count, students in 14 schools in district A benefited from re-distribution and extra assistance in resources from the district and other schools (Participant 3).

Interviewees stated staff members of this school district had always made use of data to inform decision-making regarding student performance improvements. Uses of data described by the interviewees hinted at a lack of uniformity and disparate level of knowledge among staff members. ElAtia, Ipperciel, and Hammad (2012) wrote that the absence of a systematic approach in data mining in Canadian education institutions resulted in a loss in the quality of information and insight. In a more general context, Holsapple et al (Holsapple, Lee-Post, & Pakath, 2014) considered systematic reasoning necessary for business analytics. Therefore, questions can be raised on whether this use of data in either Board A or B qualified as an application of analytics. In the past few years, a new portfolio at the executive level regrouped the functions of analysis for research purposes. However, the technical aspect of data extraction remained within the technology group. Staff dedicated exclusively to the extraction and analysis of student data represented 4 full-time equivalent positions.

In the past, numerous attempts at establishing an analytics software platform dedicated to local student data were made by the research and the information technology groups. The attempts involved multiple application vendors over a number of years and all earlier attempts were abandoned in a matter of a few months for not meeting expectations. Unless the cause of rejection was technical, applications were rejected when they failed to reach a point where they could demonstrate their usefulness in promoting student achievement. In terms of an adoption, Rogers (2003) would have described the situation as incapable of becoming self-sustaining from never getting the opportunity to reach critical mass. Pilot implementations remained confined to a small circle of interested parties. Subject to a consensus being reached among the leadership, Participant 3 indicated a certain level of interest existed in launching a new initiative as part of an overall annual technology budget approaching $5 million. A lead contender for this newest venture was viewed as an improved form of the same platform abandoned in the previous attempt.

A total of 3 interviews were conducted in District A with Participants 1, 2, and 3. They held the roles of principals in either the elementary or secondary panel, as well as that of senior executive with a mix of educational and administrative duties. Participant 3 did not supervise Participants 1 and 2 at the time of the interview. However, Participant 2 was previously vice-principal and principal in a school within the portfolio of Participant 3. The views of Participants 1 and 2 remained their own. All participants held the role of vice-principal, then principal in that same school district. Dhuey and Smith (2014) suggested a 3-year tenure at a given school was typical for a school principal before

reassignment. Although not in the same location or portfolio, Participants 1, 2, and 3 had been in their respective roles for 3 or more years at the time of the interviews.

Case B – Rural with urban areas. Participant 4 was the sole participant from School District B. School District B covers 17 municipalities, composed of three main towns with a population of 8,000 or more and a military base. Already a school board covering an entire county, School District B was left unaffected by school board amalgamations in 1998. However, smaller school authorities or individual schools previously independent were joined to District B in a separate round of consolidations in 2007. The impact of these consolidations meant serving a few new communities and did little to affect total student enrolment. The large territory and low population density meant 3 schools, each educating less than 100 students, could be viewed as viable and necessary in that district. One accommodation to budgetary constraints took the form of sharing principals of the smaller schools among multiple school buildings.

The economic base of the county is less stable in District B when compared with District A. Median government transfers to recipients of $8,076 in 2015 for the 100% data group amounted to twice the Ontario provincial average of $4,206. The same median government transfer amount was $3,215 in District A. This figure on government transfers could be interpreted in one of two ways. One interpretation was that social welfare payments would happen where poverty exists. The second interpretation was for a larger number of disabled or retired individuals benefiting from greater pension benefit payments. A cross reference with the 20.8% percentage of the over 65 age group in District B area, compared to the provincial average of 16.7%, supported an argument for

poverty being the cause of the discrepancy in government transfer amounts (Statistics Canada, 2018a).

With the decline of wood logging, the remaining pillars of economic stability are sales and service, agriculture, spending from military families, and one highly specialised technology centre. Participant 4 recognised specific challenges posed by the integration of transient military families or members of the First Nations into the fabric of schools. However, as Participant 4 pointed out, and the 2006 and 2016 Canadian censuses confirmed, the population in the county was over 93%. non-immigrant Eighty-three percent of the population were third-generation residents of the county, another 10% were second-generation residents, and the remaining7% a were first-generation residents.

School district A offered a dissimilar picture. The same statistics for School District A showed 75% as non-immigrant. The percentages in decreasing number of generations in residence within the area of School District A were 53%, 21%, and 26%. These statistics point to a generally stable and settled population in School District B. The level of education was also lower in School District B. Recipients of a university degree or certificate were young, or under the age of 35 years, and represented 10% of the population, with only 1% of the population over 35 years of age having attended university. Overall, 33% of the population of School District B held no certificate, diploma or degree, whereas School District A showed almost the reverse ,with 38% of the population having some kind of tertiary education credential and 12% with no academic recognition at any level (Statistics Canada, 2018a).

The amount of District B's budget devoted to technology, and therefore available for analytics, was less clear in the published budget of that district. A sum of $400,000

was earmarked in the 2017-18 academic year for classroom computers. It is unclear if the figure of $250,000, stated by Participant 4 as a grant for technologies directed at students with special education needs, was already included in the expenditure on classroom computers, or was in excess. Other comments collected during the interview indicated that a single person belonging to the Finance department had a subsidiary duty to fulfill requests to extract student information intended for interpretation by other parties within the board. That person had, among other responsibilities, the maintenance of the student information system and business applications. The expertise of the technology group, under the direct supervision of the chief executive, went to the hardware aspects of computing and networking. Although a separation between the two distinct functions of data extracting and analysis existed in District A as well, District A was able to dedicate human resources to the sole task of data extraction, as well as their eventual analysis by doctoral-level research professionals. In that choice, District A followed the strong recommendation made by Zegarac & Franz (2007), linking student performance with evidence-based research.

A single interview was conducted with the Director of Education of District B. The Director of Education of an Ontario school district is the chief executive at the head of the administration and holds final responsibility to the trustees and provincial authorities for all aspects of the district performance. Participant 4 had previously been a superintendent of schools within the same district. The retirement of their predecessor a year earlier allowed for an orderly transition. Participant 4 assumed the top position within District B with no other change in the executive team, other than an acting superintendent becoming substantive superintendent. The executive team's combined

experience ensured continuity and steadiness in the district. Davis and Bowers (2018) recognised the importance of peer support and mentorship in seeking leadership at the executive level.

Analysis of the case studies. This section provides an analysis of the case studies and interviews. Although semi-structured interviews are a directed process, they are not rigid as to the topics discussed (Yin, 2014). A focus and structured sections in the discussion along the three central themes of the study, addressed the resulting occasional overlaps in answers to the specific interview questions. The central themes were strategy, adoption and enrolment size.

An analytical method proposed by Corbin and Strauss (1990) allowed comparisons to be drawn between similarities and differences in the interviews. The process of open coding aims at overcoming pre-conceived ideas regarding phenomena observed in the data by attaching codes to observed data and phenomenon during the analytic process. New insight was derived from considering properties and dimensions tied to conceptual labels that were identified.

The next section investigates the conceptual label of strategy as it relates to analytics in the two Ontario district school boards that participated in the research.

Strategy and analytics. Four questions were asked to each interviewee around the concept of strategy. The complete list of semi-structured questions is presented in Appendix D and; questions specific to strategy were identified as Q2. During the interviews, these questions came second, after an initial discussion on analytics and adoption, to introduce the topic of adoption. Table 27 summarises the responses from the four interviews. The questions are repeated below:

Q2a What form would the introduction of analytics take in your school board?

Q2b For example, could analytics be introduced as part of a grassroots movement in your school board?

Q2c Would it require a centralised strategy?

Q2d What would that strategy look like?

The questions were intended to explore the manner in which district school boards perceive analytics and understand how strategy can influence adoption of analytics in this context. The first question was a general inquiry on the matter of how interviewees would consider an introduction of analytics should take place. The second question probed opinions on the suitability of a grassroots approach, where the base would suggest an innovation which could later spread throughout the organisations. The third question asked interviewees to reflect on the proposition that a centralised strategy was preferable during the introduction of an innovation, and would likely impact later adoption. The last question in this group of questions was meant to collect any relevant thoughts not covered previously. The questions are analysed in the order they were asked.

Form taken by the introduction of analytics. The first question on strategy opened the conversation on how interviewees imagined the introduction of analytics in their school district. The answers mirrored the stages in a pre-adoption phase of knowledge, persuasion, decision and implementation of the Diffusion of Innovation Theory (E. M. Rogers, 2003).

A major concern, when any change is introduced, is the unknown and knowledge of the innovation that has to be obtained. Interviewees were clear that any new tool had to demonstrate its usefulness before being introduced to educators. One participant quoted a

well-known education author on the number of educators resistant to any change, estimating them at 2 percent, and offered a mitigating strategy to minimise the impact in the same breath by stating:

> And in fact, very few were saying, “no, I don't want to try new things”. And only two percent were actively [resisting any change]. He calls them the toxic, two percent were actually fighting against it. So, it's not that people don't want change, it's that they need to know that that change has value (Participant 2).

In order to minimise the number of potential resisters required clear communication and proof of the value of the innovation.

However, a comparison with existing and widely used tools, such as the EQAO data tools, also revealed a strong desire for improved solutions if new ways were to be introduced. A recurring, sought after improvement concerned ease of use. Wixom, Yen, and Relich (2013) wrote of a similar concern in presenting a new application to users. The concept of Perceived Ease of Use (PEU) also occupies a significant place in the Technology Acceptance Model (TAM) (F. D. Davis, 1986). Existing tools were notorious for the multiple steps required to arrive at a useful result. Petter, Delone, and McLean (2013) had specifically identified response time as a measure of the desirability of an information system’s information. While noting the somewhat controversial value of the data obtained from the tool in question, one participant declared:

> The EQAO data tool, like ignoring what the data is. I have to go to the EQAO website. I have to log in. I have to go to the data tool. I have to log in, which takes me to like it's a different site I think. Then once I'm in there, I have like… There are several several [sic] steps before I start actually looking at data… (Participant 1)

The reverse of aiming at a reduction in the number of operations required before getting a meaningful result was clearly valued and preferred by the same participant when he said:

> Yes. The term dashboard to me is the opposite of that. It's turn on the computer and there's something. (Participant 1)

This strong desire for simplicity as a high priority and consideration was tempered by another interviewee with a self-declared higher level of comfort and even personal affinity with technology, who stated:

> And so, the analytics of that spreadsheet is left to the principal, who may or may not have training and may not have the motivation of even asking for the spreadsheet. So that's really problematic. Whereas we are lucky that we're big, and even if it's not the research officers, there's enough principals. Like, you know, a principal may call me and say, "[Participant's name], I'd you know [sic], can you help me with this spreadsheet?" And I can. (Participant 2)

The apparent contrast between the positions of the two participants above could not hide the fact that simplicity remained the better option to satisfy, as a minimum, the basic needs of the largest pool of potential users and drive persuasion and decision. The comments aligned particularly well with one of the UTAUT model's constructs. Effort Expectancy was defined as the level of comfort a user experienced in the use of an innovation (Venkatesh et al., 2012). The intuitiveness aspect of the tools was again not seen as a problem by a participant who declared:

> When you actually start playing with it and trying things out, most tools are pretty intuitive. I mean, they're designed to be intuitive (Participant 2).

The efforts of introducing an innovation would depend on advertising the value of any new initiative, which had to be demonstrated through pilot projects and training during the introduction, to ease concerns and prior to implementation. This last point on the relevance of pilot projects was raised by Participant 4, and echoes the findings of Puklavec, Oliveira, and Popovic (2014), with the additional stipulation that the degree of testability or experimentation during a pilot be counted among the determinants of acceptability for an innovation. This raised the topic of suitability of a grassroots introduction of analytics, addressed in the next section.

Grassroots movement for the introduction. Another theme, which developed through the interviews, was that of individuals championing innovations and a satisfaction towards a mode of management where solutions are presented by the users and agreed upon by the same. Wisdom, Chor, Hoagwood, and Horwitz (2014), in a review of research on the subject, argued that an organisational leadership favouring champions proved beneficial during pre-adoption. Under the UTAUT model, the same process would be labelled as the social influence of colleagues and their belief that an innovation should be used (Venkatesh et al., 2012). The following contribution supported those findings:

> Yeah, I really like the model we have where, if we have something which we think is going to be effective, have some folks mess with it first and then they become the spokespersons for they will champion it (Participant 4).

The concern over a solution inadequate to meet specific local needs would be reduced or perhaps eliminated with a home-grown solution. Rice and Rogers (1980) suggested an innovation had to focus on solving local problems to avoid re-invention and

represented a concern over performance expectancy in the language of UTAUT. The result of not following that advice was experienced and rejected as:

> PowerSchool has, I believe, has a dashboard or something I think. But it's... I don't know. It's generic, it's out of the States somewhere. It's it's meaningless to me. It does not answer any of my questions. If there was something dashboard-like. Yeah. If the Powerschool folks would say, "hey, what would be helpful on the dashboard for you, Principal?" (Participant 1)

A proposed solution to the problem of a maladapted innovation amounted to what Rice and Rogers (1980) referred to as "mix and match components". In an example of convergent thinking, one participant declared:

> It would be nice to have something that was LEGO-like, I dunno, like where you could have components and it could grow instead of building something that becomes an isolated area, monolithic. Because then, if you've missed the mark, the whole thing is gone. (Participant 1)

Under that grassroots model, an innovation would make its way into the toolbox available to all staff members via an initial core of enthusiasts committed to sharing their knowledge with others. They would lead the introduction and sustain the adoption as part of a grassroots movement. Two participants from District A, describing the event as a done deal, defined their district's adoption of analytics as a grassroots movement in those words:

> I think it has already been introduced as a grassroots movement. I think. Yeah, if the amount of time we spent talking about data became transformed into that action plan, right? (Participant 3)

That's analytics, that's really grassroots analytics, but it goes all the way up to the board level. (Participant 2)

While a third wished analytics was in place, but was less definitive on whether that had in fact been the case:

As a grassroots thing, okay. You know, it would be nice if we could do this. Okay, let's look and see if we can do that. (Participant 1)

In a different intervention, that participant cast a doubt over the belief held by two other participants in that same district, that analytics could truly be found in that district by saying:

Like because we don't use analytics. It's hard to say what we would use. We have… I think we've got very limited experience with it. Maybe there are some smart people out there who can all [find] a good tool. (Participant 1)

Yet, like Pfeffer and Sutton (2000) pointed out, the same participant remained concerned about the challenges met by a grassroots movement in ensuring knowledge transfer, even within the confines of the same organisation. The facilitating conditions of UTAUT addressed matters related to resources and support as encouragement to a given behaviour (Venkatesh et al., 2012). In that person's view, a serious obstacle could be found in the mechanics of using an innovation from a lack of prior training:

Lack of awareness. Yeah, lack of training. I mean, other than this Powerschool. Other than I think the initial here, we've never had any [training]. (Participant 1)

That participant went on to cast doubt on the relevance of well-intended local initiatives by insisting that all activities around analytics were not always within easy grasp of the less technically-savvy users:

> Yes. We did an activity with... an activity at a principals' meeting earlier this year where we took data from the data tool and we cut it out and we put it in a chart. And then that chart was uploaded to Google like it was a multi-step very technical process for a principal to be doing. I haven't looked at it since. You know what I mean? Like was their value in it? Maybe there was like, but it was a lot of work. (Participant 1)

The comfort articulated by Participant 2 in trying new tools hit contrary evidence presented by Participant 1, for whom additional guidance in their first steps was required for the introduction to prove effective and permit a fuller access to the untapped functionality of existing tools:

> I think there's technologically and data-wise.., I think there's a lot of resources there that we are not using to its full potential. (Participant 1)

The contrasted contributions suggested a grassroots introduction was highly prized for the signal of commitment it gave, as long as it was followed by the eventual buy-in of previous outsiders joining in. However, such a model of introduction strategy would be vulnerable to individual inclinations, or lesser interest towards technology, unless framed by a support structure with resources that are harder to find in a grassroots movement. While an existing organisational and technical infrastructure was assessed as part of the facilitating conditions found in the UTAUT model (Venkatesh et al., 2003), that infrastructure initially would not be in a position to address new emergent solutions from a grassroots movement. Given time and with adequate commitments from central authorities, this gap could likely be remedied.

Centralised strategy required? Dispensing with the involvement of central resources may not be workable under all circumstances. On a matter of capacity, one participant supported an unspecified level of participation from the echelon above schools in the organisational structure. However, any contribution from the district-level could not lose track of the end goal of serving the base customer, whether in a classroom or an office:

> So yes. Okay. Because it requires centralised and I think it requires grassroots. It requires centralised because central has the capacity to…, and when I mean centralized, Board or Ministry. But I think it requires grassroots because it's the grassroots. It's the end user. (Participant 1)

Participant 2 was more definitive in rejecting an exclusively centralised strategy in the introduction of analytics. The introduction was, in that participant's opinion, a matter for everyone to get involved in and could not be delegated to another body or group, even within the district:

> No, I think, I think it's everybody. So, I do think there needs to be a centralized strategy. I'm a big fan of the, I think you've studied it, is the TPACK model? (Participant 2)

The combined effort, as envisioned by Participant 2, did not exclude the core administrative functions of the district from participation, but required all parties to work together. The role of the core district functions, under that vision, was one of coordination, aimed at defining the end goal and the means to reach it, before becoming interested in analysing the results. This approach followed the logic of the TPACK model

(M. J. Koehler & Mishra, 2009) at the confluence of the technological, pedagogical and content knowledge domains of the educators engaged in analytics activities:

> We need a centralized strategy where we say, okay, what is the tool? So how do you use it? And then we look at… in like rather than pedagogy we look at, so what is the meaning? (Participant 2)

For the Director of Education of School District B, the central body making recommendations on technology issues was a committee with representation from the executive, principals, classroom teachers and the district's technical coordinator. The committee formed a forum for discussion, rather than a decision body. In one specific instance, the Director recalled what occurred:

> So I remember having discussion at the time, electronic portfolio. And so there was, you know, do we as a system say we're going with D2L or where? We didn't. We didn't mandate anything. We said, what works best. (Participant 4)

This interviewee referred to the expression "collaborative professionalism", a term coined by the Ministry of Education in a policy document, , to explain how board staff were expected to, and did, work together, sharing their knowledge, skills and experience to push forward an agenda aimed at improving student achievement and the conditions at work or school of both students and staff (Ontario Ministry of Education, 2016).

The committee approach as a strategy to bring analytics into a school district was seen as being unworkable by a principal already involved in numerous committees:

> The problem with that is it might just be too big, too great because he you'd need representation from everybody. That'd be a really big committee, you know, and

> then everybody has specific needs. So, I would see it one level down from an overarching committee, whereas you would have like a Spec Ed subcommittee that talks about analytics or in Leading and Learning that talks about analytics in terms of how we're developing leadership in the board. You know, a subcommittee on numeracy which really kind of already exists with our leadership structures. And it's just, it's just I would think whether it's a directorate or the associate directorate saying, “you as part of all of your subcommittees analytics needs to be a topic.” I would see that is more functional than having some huge unwieldy thing where everybody's got different needs anyway. (Participant 2)

In the clearest rejection of a centralised introduction recorded for this study, Participant 4 declared a clear preference for a model which was not top-down and centralised. This model, reminiscent of one proposed by Hargreaves and Ainscow,(2015) was a hybrid approach, seeking to correct weaknesses seen in systems following only either a top-bottom or a bottom-up strategy and applicable in education, as well as other fields of activity (Hargreaves & Ainscow, 2015; Hargreaves, Shirley, Wangia, Bacon, & D’Angelo, 2018). The participant stated that:

> I can't think of too many. I can't think of any effective strategy on any initiative that we would have going that is a top-down by memo or by fiat. (Participant 4)

However, the relevance of a centralised approach was considered by one interviewee, given specific circumstances where legal obligations demanded uniformity in service delivery. The emphasis on collaboration and choice left up to teachers had to be cast aside for students with special education needs and entitled to Special Equipment

Amount (SEA) funding (Ministry of Education, 2011) to assist in their learning, as in the following example of a centrally imposed strategy:

> So I think, you know, centralized strategies. We really have to work collaboratively across the departments. So my next goal is to have… We are going to do a grade 7 project for every grade 7 teacher. It's not optional because it's based on students that have SEA equipment, who have a legal right to use their device to access digital content. (Participant 3)

A concern for all students to benefit from equal opportunities in order to achieve academic success was present in the reflections of participants. The concern for students and staff was professional, as well as personal. On a professional front, the superintendent of schools interviewed said:

> My mission is how many schools can I affect with the money that's available, the Students services department to meet individualized needs and technology to take the deep learning framework now and say, "hey, I have my eleven schools. I have a lot of control over and intimate relationship with each principal and what they're trying to do. You know they're… I do their performance appraisals. They set goals. They have to have measurable goals for me. They have to use data to drive it, and they have to be responsible for every classroom in their school, not just their school in general. (Participant 3)

The personal passion for the mission and work came through as well. Comments, such as what follows, also hinted at a need for concerted efforts from a central perspective to address issues larger than those covered by the single portfolio held by one superintendent:

> No, because these kids deserve the same as these kids, so that equity social justice piece. So now we've got 14 children's support schools that we can directly influence with this messaging, the director and the associate director are very involved in those 14 schools now. (Participant 3)

The matter of the necessity for a centralised strategy could be settled by a qualified positive response. The answer was neither unambiguously for, nor against, and was dependent on other factors. The lesson was that, despite hesitations to even give a reserved yes, participants gave the impression of being more comfortable in saying collaboration would prevail in all instances.

The next question opened the discussion on the deployment of an initiative related to analytics. This last question on strategy was a blanket question, an attempt to ensure important themes were not missed.

Appearance of deployment strategy. The willingness to experiment and end failed experiments without hesitation transpired in responses to this question. Although the issue will be treated in more depth during the discussion on adoption, the mention in some interviews of ending a failed adoption attempt at this stage was unanticipated. The matter spoke loudly to the fact that there would be no blind obstinacy to pursue a line where concrete results were not seen rapidly. This suggested the need for careful planning ahead to ensure value would be evident and straightforward. Individual reaction to a poorly conceived, as well as executed, plan could result in a strategy of waiting for an initiative to die out while taking other means to achieve similar results, as indicated by:

> And what, it lasted a couple of years and then was gone? (Participant 1)

A further point on this line of reasoning, and perhaps not conducive to the very idea of analytics, was the expressed reluctance to conduct rigorous scientific research in the form of randomised experimentation on student subjects. Research conducted by Cook (2002) had expected, explained and rejected averseness to this form of research on the grounds of pragmatism. The ethical dilemma and struggle of educators over randomised experimentation was plain in the perceived conflict with their mission in the following:

> I […] have learned a lot from her about pure research, about what ruins research, what [laughter] authentic research is. And then, you know the biggest thing for me was they always wanted to have a group that was not affected by what you were doing. And I never agreed with it because I said, "I don't wanna do this if we have to have a group of students we're not helping." You know, it just doesn't work for me. You can't say we're going to ignore those kids and just work with these kids to see if this is effective. Your research might be valuable, but it's immoral to ignore a group of students and not give them the advantages that you have because you know, what would help them learn better. It was always that you know, "well, we need, all researchers, we need that". (Participant 3)

Negative experiences with data collections for the purpose of analytics at a provincial or global level with real local implications for the smaller district spoke to the importance of laying out, in advance, operational details likely to ease apprehensions over the onerous nature of the exercise. An expression of that concern took the form of:

> So just in terms of when EQAO or PISA is doing some assessments because we only have the two high schools, one or the other is often, sometimes both, are

> always included in the sample. So, I've actually at some point exchanged with somebody at EQAO, "You know, this is a little bit frustrating because there is some workload involved and every year we're being asked to participate in some sampling because we only have the two high schools." It's a little easier with eighteen elementary schools that not everybody picks the same. (Participant 4)

The main drivers of a successful deployment strategy remained value or usefulness. Reflections on existing tools pointed to an unfulfilled need:

> I think it doesn't reflect my needs. If it was…, if the analytics tools were something that were useful to me, I would use them more frequently, maybe. Because I'm interested in and I feel that there is information in there. It's not accessible to me. (Participant 1)

Solutions to address the problem of deployment strategy were forthcoming and involved broad discussions on defining the needs by embedding the topic of analytics in every internal meeting in order to seed reflection. One interviewee's suggestions for a way forward could by summarised by:

> I think you would have to look at each of the superintendents' portfolios and think system-wide. What do we need out of this analytics tools, and then they would have to have to talk about how are we going to disseminate that to people who are actually using these tools? So, I think that would be the model I would look at. It would need superintendents. They would have to say what our analytics needs are. To get agreement might be a different story. (Participant 2)

Coombs, Dohertym and Loan-Clarke (2001) asserted that reaching policy objectives was, in large measure, connected to a form of user ownership in the initiative, brought forward to assist with attaining the goals. Interviewees agreed:

> So, the superintendent would come to that meeting with an idea, “Ok, we might wanna go in this direction or that direction”, brings up conversation to that table. And then it's kind of fleshed out from there. So that there is the ownership piece, there's ownership. (Participant 4)

At that stage, the slim content of discussion pertaining to deployment strategy served as an indication the topic had been discussed to the point of exhaustion. Therefore, in turning to the next series of questions, the following section, found after Table 27, is devoted to questions related to adoption of analytics in the two districts involved in the research.

Table 27

Responses related to Strategy from the interviews

	Characteristics	Perceptions	Key points raised during interview		Remarks
			Value proposition/meeting needs	Competitive Strategy	
Case A	Large board More financial options	Additional support required for existing offerings Insufficient awareness Complexity in access and use Not a time-saver Can be inadequate to local uses Readiness to let go of failed initiatives	EQAO data tools ubiquitous but limited Drilling down to the individual student not possible	Grassroots or centralised A modular or LEGO-like approach to meet needs incrementally Focus group	Consensus on value Participants 1 & 2 favoured grassroots. Participant 3 leaned towards proposing a central solution
Case B	Small board No financial freedom	Requires emergent solutions	Known needs are met. Currently unsure of cost/benefit of local initiative	Grassroots Champions Pilot Leading from the middle Collaboration	Demand and solution should come from the base

Adoption and analytics. A total of 7 questions were devoted to the concept of strategy. Table 28 summarises the responses from the four interview and the complete list of semi-structured questions appears as Appendix D in this document. Questions specific to strategy were identified as Q1 and Q3. During the interviews, these questions came midway through the interviews, after an initial discussion on analytics and adoption, to introduce the topic of adoption. These questions touched on a number of subjects relevant

to UTAUT, especially Performance Expectancy, Social Influence, and Facilitating Conditions. Effort Expectancy played a lesser role. The questions addressed in this section are repeated below:

Q1a What is your understanding of analytics in general, and the use of analytics, in particular?

Q1b How did you hear about the use of analytics in education?

Q1c What would you find appealing with analytics for your school board?

Q1d Are there support services, or resources you would consider essential to introduce and use analytics in your school board? Please describe those.

Q1e If your board were to adopt an analytics tool, such as Compass, how widely would you want to see analytics made available in your school board?

Q1f What specific circumstances or challenges would prevent you from considering analytics in our school board?

Q3a Assuming your board were to adopt an analytics tool, which approach and steps would you envision for the deployment of analytics in your school board?

Understanding and use of analytics. This question (Q1a) opened each interview as a framing exercise and was not intended to yield much insight into the researched topic. The text-book answers were clear and touched on the main ideas present in a description rather than a definition proposed by Cooper (2012), namely a process, actionable insight and data. The two executives placed an emphasis on education. Two of the definitions are shown below:

> So, analytics is taking data, analyzing data and gaining insights to act for decision making. (Participant 1)

> Well so my understanding of analytics is it's the collection of any kind of data that informs decision making. (Participant 2)

Once an understanding on the subject at hand was confirmed, the interviews could proceed with the second question.

How did you hear about the use of analytics in education? Awareness of analytics came in organic fashion and as part of the professional activities of the respondents. Interviewees could not recall the very first time they had heard of analytics. However, they could remember multiple instances where analytics was discussed. Illustrating that point were comments such as:

> I don't know if there's any one time when I heard about analytics, but it's something I've always been interested in from once I became a vice principal and all the way through to becoming a principal. (Participant 2)
>
> I think over the years, you know in your different positions during different conferences. You attend different, different initiatives through the ministry and certainly EQAO. (Participant 4)

These opportunities to discuss, or witness, applications of analytics were still seen as insufficient by Participant 2, who deplored this lack of exposure:

> It has [come up] in conferences. I mean, probably not enough, to be honest with you. I mean, the conferences will talk a lot about pedagogy or computer applications, different innovations, but it's, you know, I don't know if it's a real sexy topic and so I don't know [if] it makes it into many conferences, but... But it really should, you know. I think it's an important thing and could improve how we run our schools. (Participant 2)

Little more could be extracted from answers in relation to this question. In effect, the conversations had begun at this point and interviewees were anticipating the following question by having specific and everyday applications in mind relevant to their professional practice. The next topic was specifically addressing the appeal, or lack thereof, of analytics in a local context.

What would you find appealing with analytics for your school board? Responses focused on immediate needs perceived as being met in inadequate ways. An example was the comment below on student attendance. Despite the availability of many attendance reports in School District A, the gap remained in providing that information to the less technically-inclined individuals without time-consuming efforts:

> It prompted me to think about the things that I kind of wish I had as well, which I don't have, like you mentioned attendance. […] The Children's Aid Society will call up and say, "can you give us the attendance records for this student?" Okay, yes we can, but it's very manual. (Participant 1)

Attendance as a safety concern was mentioned previously, and timely access to the current whereabouts of students was deemed important. Concern for the continued physical well-being and how to access data could help ensure student safety was also clear from the participants' responses:

> You say, okay, we need a way of tracking or of listing out all students who have life threatening allergies. (Participant 1)

The appeal of analytics was considered for the mandatory and annual administrative task of drafting a school's improvement plan by school principals. This draft plan was then discussed and finalised with the superintendent of schools responsible

for that school, then collated as part of a Board Improvement Plan. Ignoring data in the preparation of the school plan was considered unwise:

> You know, if principals are making decisions about their school improvement plans and they're not using analytics, I think that's problematic. Because where the work is done is in schools, it needs to be based on good decision making, right? Good. Good modeling. (Participant 2)

As suggested by Hambrick (2007) in his upper echelons theory, first developed with Mason in 1983, the two executives, from their common vantage point and experiences, had a slightly different perspective on the question than the two principals . These points of convergence came through so strongly as to overcome the theorised individual variations. Executives had less interest in thinking in terms of a single school and they turned their attention instead to student achievement or results in numeracy or literacy at the level of their respective school district. Their interest in analytics related to its applicability to these areas:

> Yeah, and I think for me we've been striving for the ultimate student profile, right? So that we could have easily accessible one page for the kids I'm teaching to tell me their whole history. (Participant 3)

Attempts by the interviewer to bring the discussion on the benefits of analytics to financial matters, and the insight into support functions permitted by analytics, held little interest for educators in the context of this study, even for executives used to handling the district's budget. As this was not the focus of the research, the matter was not pursued. The contribution of superintendents of business or by line managers of support functions would have been required to pursue that line of questioning.

Once more, analytics was first considered by participants for its potential to address pressing daily problems. The principals interviewed expressed an obvious preference and their priority to dig down for information in the data to the level of the individual student, over assisting in support of system-wide decision making. The desired functions were focused on academic analytics where it touched on learning profiles, identifying students in academic difficulty, and less concerned with issues of interest to business intelligence, such as taking operational and financial decisions (van Barneveld et al., 2012).

The discussion moved then to local obstacles or facilitators in the adoption of analytics.

Support services or resources considered essential for analytics. The need for support was evident in the participants' responses and took multiple forms. Principal peers and superintendents, in their role of supervisors to principals, had experienced efforts made by the district to assist in coping with data. These efforts included the existence of research officers on staff at District A. However, a lack of communication on the subject was still noted:

> Yes. [Communication] could be improved. In terms of analytics, there's yes, our researchers will offer to come out and help us. And I've had superintendents who encourage me, they say, "have you looked at EQAO results" and that sort of thing. Beyond that, there's not a lot, there's not a lot of talk about the use of data. We've had, we do have some principals' meetings where we'll take our schools' EQAO data or we'll take school climate data would be another piece of information that we sit at. Look at. Look at the responses. (Participant 1)

The presence of research officers in school district A came up again in the praises of the other principal. Suggesting additional efforts were required at the district-level, the necessity of training could not be ignored, and indications were that more training was required to make full use of the data available:

> Well, we've got data officers in our board and they're invaluable, I think. I think we made a really good decision when we started hiring data officers. Having said that, I think it's important that there is training going down to the school level because the data officers can't handle the 100 schools, right? They can support on a central level and send out reports, but I think where we can get training, so people create their own reports, that's more locally based. (Principal 2)

That sentiment was echoed in the regret expressed by the Director of Education of District B, where one generalist individual performed requested extractions of data and formatted them in readable format. Out of necessity, the analysis of the data was left up to the original local data requester. The gap in that valuable human resource could still not be made into a budget priority in a smaller school district:

> And so, to have a person to me would be the key resource to have the funds to be able to dig in. (Participant 4)

The value of the conversation on data was plain and the role of the Managing Information for Student Achievement (MISA) initiative in generating interest was brought up by both executives. One interviewee emphasised the critical importance of the financial contribution MISA made in permitting talks on data:

> So again, we have a MISA committee, but that's funded by the ministry. And in the absence of that, I don't know if we would have the Board dollars and for us it is not

> a lot. It might be a $40,000 allocation, but if we didn't have that, we wouldn't have some of the time. (Participant 4)

Informed by experience with other IT solutions, Foster, Hawking, and Stein (2005) expected maturity to set in with the business intelligence process. That appeared to be the case when the other participant praised the evolution of MISA, from a simple financial grant source, to a body for meaningful talks on the use of data:

> My attachment to MISA in the past before I took this role as superintendent of technology was it was a source of funding. So if you wanted to access the funding that MISA made available, you had to use data and you had to produce data. You had to monitor, you had to create a very specified use of data and reporting tools. So, I did that formerly. Now, MISA has changed dramatically because there's so much data available now. It is gone far more to what is the pedagogy? How do you measure the change in teacher practice to access current data and then show improvement? So that's been kinda neat. (Participant 3)

The challenge resided in providing the right solution. There was no ambiguity in what constituted the right solution, and the purpose of services and resources assigned to analytics. In its simplest form, the equation consisted of the teacher, the student, and some form of conveyance, to maximise the delivery of assistance from the teacher to the student to achieve the best outcome. The words spoken remained true to that guiding principle of student achievement:

> I want a tool so that every teacher can know the whole history of every student, and then their plan is what are you going to do about it? (Participant 3)

The scope and scale of an eventual deployment of analytics guided the following question. Although the question of benefits from scale was not the primary focus of the question, the issue was introduced by the participants themselves in the discussion.

Desired extent of availability of an analytics tool. Concern over money was the exclusive domain of executives. Throughout the interviews, the word "money" came up only once with a single principal. Executives used the word 18 times in various contexts. One such instance for District A was relevant to the issue of scale:

> So, I say to the Student Success department, 42 elementary schools said yes to MathUp. And they keep saying everybody that asked for it got it. Huge expense, huge amount of money, all digital, fabulous resource. But it's a resource. (Participant 3)

The primary areas of concern were the diverse reasons behind schools electing not to participate in a district-wide initiative. Many causes for not getting involved in an initiative were supported, reasoned and deemed acceptable:

> And I say, "so don't you worry about the 40 odd schools who didn't say we want it. Don't you wonder?" And for each school you speak to it's a different reason. No, we've already bought this. We're focused on this. We've got a year in. We don't want to change our course because we're really seeing some progress, so we want to stick to the plan. I promised my teachers I wouldn't keep changing. (Participant 3)

One cause of non-involvement was identified as a missed opportunity from a moment of distraction on the part of a principal who failed to notice an electronic

message. That particular cause of non-participation was harder to justify due to possible negative impacts on individual cases of student achievement:

> [A research officer] and I look at schools that aren't involved in very much. Try to figure out why. Again, lots of it is because the principal says, "yes, we'll do it". And if your principal doesn't say, "yes, we'll do it", you miss out on that whole math initiative or literacy initiative. So again, sometimes the principal just misses the e-mail, puts their hand up, and then they go, I, you know, I say, why? (Participant 3)

The idea that a comparison with other districts, schools within the same district, or students belonging to the same classroom, was considered less suitable than a strict focus on the individual students.

> I mean, I think if we look at large scale EQAO scores for instance. The analytics of that over time for school board is a very big generalization. […] But when I look individually at what EQAO scores include, you know, if you take it down to the school level. […] If four out of eight of those students are in grade 6 and they get zero and it's counted in their EQAO scores. To me, the board's EQAO scores mean nothing to those teachers because they are dealing with all these students. (Participant 3)

Consensus existed in wishing analytics to be made broadly available to all staff involved with students, along with a realistic view that simple access would prove insufficient to drive usage, and had to be accompanied by support initiatives. The opinions of the two principals were noteworthy in their agreement on the necessity for the adoption of any analytics tool to be a process offering assistance to users:

> So, I think that virtually everybody in the school building could benefit if there was a tool to pull up the data, I think though we have to move beyond. Like I said, we collect data, but then we just kind of push it aside. (Participant 1)
>
> Well, I think any tool that supports good decision making should be made widely accessible. I think the availability wouldn't be the issue. It's telling principals here's the tool, and this is why you want to use it, but they don't understand why it's going to help them with their decision making. Then it'll sit on the shelf and you know like this, it's gotta be hand in hand. (Participant 2)

With the matter of the ideal scope of an analytics initiative settled in favour of a universal and open access by all parties authorised, the attention turned to predictable obstacles in the way of analytics adoption.

Specific circumstances or challenges preventing consideration of analytics. The demands of the role of school principal was deemed worthy of deserving a solution to alleviate, and not add to, the workload. The concern raised by one principal indicated their expectation that any new initiative would fulfill a need for gains in efficiency:

> So I think the busyness of the job… as much that can be automated, I think would be beneficial. (Participant 2)

The necessity of training remained a recurring theme throughout the interviews. Principals showed their concern over an analytics solution offered without sufficient guidance. This apprehension likely came more from the hypothetical nature of the conversation, rather than poor prior experiences with some technology deployment.

> And if they [the teachers] if they know the questions to ask, then they'll seek out that data and then start making decisions about their pedagogy based on that data.

> But if they don't know where to start, if they don't know the questions to ask, and that's training, then again, they won't use it because they won’t know the purpose of it. (Participant 1)

Restricting access to authorised parties only was a significant privacy consideration and challenge mentioned by both principals during the interviews. Despite a possible impact on the usefulness of analytics, accessing confidential information on students had to be controlled and monitored without fail. The challenge came in the way of controlling who could see information and what information could be seen:

> I don't know if there's anything that would prevent me, but I think the challenge is making sure people are observing privacy. And I think you need really good tools to give people access to data for which they actually have a need. Because if you open it up too much, I mean. You're looking at data, but let's say its student data, you're looking at students for which you don't even teach. That's a privacy issue, you know? So, the tools have to be tailored so that you only are given graduated access based on your position of responsibility. (Participant 2)

Although mindful and vigilant on the need to protect students, participants also considered the effect on insight of truncated data, where meaningful data was hidden to promote privacy at all cost and to all audiences:

> Like averages. EQAO-wise, EQAO does not publish the results in schools where there are fewer than 15 students writing, because you can identify individuals. I also think that some statistical analyses are like less meaningful in a school where there are small number. In a school like this where I've got 20 kids writing EQAO.

> I can kind of look at those kids individually, whereas in a school where you've got 80 students. Okay. Now we're talking maybe something more. (Participant 1)

The discussion of question Q3a addresses the vision of interviewees on a possible deployment of analytics.

Approach and steps for deploying analytics. Despite their best effort, school principals found nothing not already covered to add in response to this question. Executives reiterated points raised earlier. The importance of a committee approach to define requirements prior to any further investigation was brought up once more. A novel and unspecified approach for evaluating students without marks intrigued one participant in how it seemed to avoid analytics. All information on this topic appeared to have been already shared by that point and no new material was volunteered.

Therefore, following Table 28, analysis of the effect of student enrolment size and its impact on the adoption of analytics is addressed next.

Table 28

Responses related to Adoption from the interviews

Case	Defined analytics budget?	Have Analytics dept?	Budgetary commitment to analytics?	Key points raised during interview		Challenges/ Remarks
				Strategy or policy in place?	Value in analytics?	
A	No, could be created	No, duties split between two departments for extraction and analysis	Staff committed	Yes Broad dissemination Economy of scale MISA, a conversation starter	Yes Directed at student achievement	Priority should be given by embedding in all discussions Privacy
B	No and lack of available financial resources	No, one shared individual for data extraction	No Dependent on external sources of financing	Broadly available MISA as a financial enabler	Yes Student	

Size of student enrolment and analytics. Although a central point of this research, the effect on analytics adoption relative to the student body size was concentrated in 2 questions and set at the end of the interviews. During the development of the research methodology, a concern regarding interviewee fatigue led to the choice of concentrating the questions, and their position in the chronology followed a sensible progression. Reality proved the worries over dealing with busy leaders in their respective organisation were correct, as some interviewees, by that point, had other matters on their mind. Questions specific to student enrolment were identified as Q4, and these questions closed the interviews. Table 29 summarises the responses from the four interviews. The questions are repeated below:

Q4a Analytics have assisted organisations on issues of understanding data, in suggesting likely outcomes (predictions), or addressing staffing shortages. From your

understanding of analytics, is your school board facing these or other challenges where analytics might help?

Q4b Would you consider the particular circumstances (location, enrolment) of your school board to favour or hinder analytics' adoption?

Is your school board facing these or other challenges where analytics might help?

As noted above, regardless of size, there was little interest among the educators interviewed in justifying analytics for its potential impact on business functions. A principal was focused on ensuring their main purpose tied to student achievement would be impacted in a significant and positive way by any new initiative. That sole reason, while sufficient to justify costs involved in equipping a school district with analytics, would ignore other potential benefits on student performance or operational effectiveness. McLeod (1984) described the nervous preliminary work done in the executive meeting room as a dress rehearsal prior to involving school district trustees on major expense projects decision. Macfadyen et al. (Macfadyen, Dawson, Pardo, & Gašević, 2014) spoke of the potential to use analytics for systemic institutional changes. However, the example below illustrated how, whenever the subject of business functions came up during interviews, the discussion promptly reverted to the professional role and focus familiar to a school principal:

> I think analytics helps with any challenges that you might face, whether it's an HR issue or a pedagogical issue. So yeah, so I mean if we're talking about math issues, whether it's grade 3-6-9, whatever. (Participant 2)

Another contribution by a participant was in line with the subject discussed. However, an issue of excessive absences by a teacher, once documented, would rapidly

become an issue dealt by other instances within a school district. Aside from the human empathy towards a colleague in distress, the recognised operational impact of a teacher's repeated absence (Shet & Segrott, 2016) likely drove the primary concern to shift to see to an unattended classroom, and not the cost to the district of such absences:

> Like, staffing and teacher absences system-wide. Okay. What are the trends? Is it Fridays that all the teachers are away? Okay, what can we do to respond to that? Yeah? (Participant 1)

As expected, the richer contribution of executives moved the discussion to an organisational level above that of concern to a principal and the subject of staff attendance and sick leave was brought forward again. The objective facts, revealed by a multi-district analytics initiative on data from absences due to sick leave, exemplified the importance of evidence. This evidence informed talks between the districts and two of their unions, CUPE and OECTA, to support the respective positions of the parties in the sample below:

> And so we brought to the attention of our CUPE, who was very open to the conversation, OECTA not so much, but he acknowledged that's a real problem when you have the data in front of you, as opposed to, well, I think we have a lot of…(Participant 4)

The language used by participants sometimes suggested a cautious relationship between district and unions. Student enrolment size, as discussed in the interviews, had no impact on the desire for analytics adoption to address problems with staff absenteeism. Both districts dealt with different locals of the same unions for two large groups of unionised employees. However, four distinct illustrations of that caution from one

executive should not be viewed as signs of antagonism opposing districts and unions. They captured the thoughtful mutual respect of two organisations aware of having to work together to best serve their own constituency and interests:

i. But I think because of union pressure, we've been made to back off, right?

ii. I think that the unionized environment presents some significant challenges in...

iii. So, I think those are the challenges that providing the sources of information to the teacher doesn't guarantee that the teachers are educated enough or adept enough or willing enough in our union case to change the way they teach so that they actually do meet everybody's need.

iv. We bumped into union.

The discussion turned to the last question of the interviews. After reflecting on local challenges that could be addressed through the application of analytics, participants were asked to look at factors which could help or hurt adoption.

Are special circumstances in your district favourable or not for analytics' adoption? A form of competitive pressure was felt when comparing some of the academic results and services offered to parents by District A with those of the local French-language board. Although ultimate outcomes are impossible to guarantee in advance, efficiencies brought about by analytics suggested an interest in closing the perceived and real gap in capabilities and results with other districts:

> The French Catholic board is amazing. Their test scores are amazing. They've got a parent portal that the parents can go in and see the progress of their students, see their attendance. They built it, they paid for it. It's beautiful. (Participant 3)

The realities of the situation when the interviews took place were seen as another pressure to excel. Comments and actions by provincial authorities hinted at a desire to reduce the costs related to publicly-funded education, and represented a potential threat to the continued existence of school districts as constituted at that time:

> You know, when we look provincially at Toronto. Huge board. If you look provincially even with the election, what will happen to the school boards? We still have as many kids to teach, right? We still need as many physical, maybe not as many, but we still need seats in classrooms… You know, if you look at the current [political] leadership in the province, his comment was, you know we have two Taj Mahals in Toronto. One for the public system and one for the Catholic, the school boards. Why do we need two Taj Mahals, can we not have one Taj Mahal? (Participant 3)

In considering the impact of size on analytics' adoption, one participant saw a clear challenge in leading a larger school, and the potential benefits of analytics in helping address the task of making that large school feel small, as advocated by Krueger and Whitmore (2001):

> I think it's definitely more helpful when you're in big schools, especially, you know, from the leadership level because there are so many kids. You know, I think the challenge of a big school is making a big school feel small, and so the more we can use things like that in analytics, it drills down right to the classroom because whether you're a school of 1,600 or a school of 600, there's still a teacher with 20 kids or 25 kids in front of them. (Participant 2)

Although both are involved the same activity of primary and secondary education, the two participating school districts were dissimilar in the scope of their respective operations and the population they served. The larger district had an enrolment almost 10 times the number of students as the smaller district. The direct consequence of the size differential was that many aspects of the boards were affected. More students meant more schools and more staff. Although demographic and socio-economic conditions of the population served had no impact on curriculum, there was an impact on curriculum delivery. Services offered were affected by the size of the student body. A critical mass could not always be reached to offer the same breadth of course choices in the smaller district. Students with issues of academic performance, or their ratio to their higher-performing peers, were not a discriminant characteristic. Students with varying levels of achievement were found in both districts. While more difficult to achieve in the smaller district, a school in the larger district was able to absorb the cost of running courses with few students:

> Yeah. Well, they don't know which teachers, but I mean they can get a sense, especially in smaller schools. But yeah, I mean that's a more natural use of analytics in that, you know, kids will choose whatever courses they choose and then we make decisions, whether or not it's sustainable. But sometimes we run courses small because it's a pathway. You know what I mean? If it's a specific computer course and there's only eleven kids taking it, but it leads to a very specific… like we might eat that. We might say, we're not going to cancel that because it's a course that's required for college programme. So I don't know if that's a hugely technical analytics example, because I mean, it's just a natural flow. (Participant 2)

A previous quote by the chief executive of the smaller district, in their answer to Q1d, found agreement with the statement of a principal about the challenge for a smaller district relative to analytics' adoption being tied to the size of the budget available:

> That's what I mean. But that's where that board will struggle with. The problem in a smaller board is they don't have that budget to hire research officers. (Participant 2)

In closing, the chief executive of the smaller board saw the positive of District's B smaller size for data-driven decision-making. However, the extract in context did not reveal whether or not that comment supported analytics adoption for District B:

> I think we would be particularly well placed. So sometimes we don't necessarily have the monetary resources that a large board might. But the fact that we're small, I think, allows us to be more nimble and to kind of investigate things in a quicker way. So, in a very quick way I can... It would be very simple to pull a report on a family of schools. Very simple to do that. We have 4,600 pupils in our board. So, it's very easy to get a very quick snapshot of whatever issue I might be interested in. So that to me, that works in our favor. (Participant 4)

This section on the impact of student enrolment size identified some challenges and factors for and against adoption of analytics. Concluding remarks regarding the analysis of the interview data are presented after Table 29.

Table 29

Responses related to Size of Student Enrolment from the interviews

Case	Characteristics	Perceptions	Key points raised during interview		Remarks
			Strengths	Weaknesses	
A	About 40,000 students		Qualified staff in research and IT Relations with unions	Resources for scope of deployment Privacy Unions Comparison with other districts Further consolidations?	
B	About 4,500 students		Small and nimble to accept alternative solutions Unions	Finances	

Summary of interviews analysis. This section considered the findings drawn from the four interviews conducted in two school districts with different characteristics, in particular when it came to the size of the organisation. The analysis followed the three major themes of this study, strategy, adoption and size of the student enrolment. The comments also hinted at a convergence with themes present in the UTAUT model.

The process could be likened to four of the five stages in the decision innovation process of the Diffusion of Innovation Theory. The strategy for introduction or pre-adoption consisted of identifying the right tool. Without fail, interviewees linked the introduction of analytics as an innovation to strategy, geared to proving the innovation's value to the potential users. The demonstrability of value was predicated by the ease of use of the innovation and had to establish how tasks were facilitated, or even simplified, through the availability of the innovation, as well as setting both a level of Performance

Expectancy and Effort Expectancy. The strategy, at the time of introduction, needed to include a phase of familiarisation with the innovation as a key facilitating condition. Training was deemed essential to ensure the broadest acceptance among all users, regardless of their comfort with technology.

The idealised introduction strategy in the two districts presented a mix of elements from a grassroots movement and a centralised approach. A strategy that would follow an incremental model and a radical shift was not called for (Forés & Camisón, 2016). The consensus reached by an early group of testers would expand to new users out of social influence and draw attention at the district's core, which would commit resources to first expand, then sustain, adoption and facilitating conditions. This realistic strategy called for earlier involvement by the district in the initial selection of the proper tool and solid support at a later stage, leaving intermediate steps to a collaborative process.

The analytics tool would need to be offered to classroom teachers and principals, as well as executives. The tool would also need to cater to the different needs of users at different levels in the hierarchy. School principals thought in terms of the students in front of their classroom teachers and the safety and well-being of these students. Executives had a broader view on issues and the authority to reallocate resources. For the interviewees, the appeal was rapid access to information meaningful to educators. Mundane tasks, as well as complex ones done once a year, could be facilitated by analytics, to increase accuracy and timeliness of decision-making.

The presence of research professionals on staff was estimated as an advantageous facilitating resource, supporting the development of a mature organisational culture

revolving around information and contributing to the success of an adoption of analytics. The already considerable role of research professionals, where they existed in disseminating knowledge, could be further increased through more direct contacts with educators for knowledge transfer. However, scarce availability of financial resources made data or researcher professionals less likely in smaller school districts.

Discussion of Quantitative and Qualitative Findings

This section presents the results of the survey and interviews, structured according to the four research questions:

1. What are the key determinants of analytics adoption in Ontario K-12 district school boards?
2. To what extent is a strategy necessary for the adoption of analytics by these school boards?
3. What strategies have been used for analytics adoption?
4. To what extent does the size of a school board and student enrolment influence analytics adoption?

The conclusions from the inferential analysis differed slightly from the interpretation of the evidence gathered during the interviews, on the importance of Facilitating Conditions. The statistical significance of Facilitating Conditions could not be supported and the FC latent variable was removed from the last estimation. The relative importance of Effort Expectancy in their intent to use the innovation, a point emphasised numerous times by one interviewee, was obviously shared by other respondents and showed a path value equal to the sum of the paths of the other two endogenous latent variables, Performance Expectancy (PE) and Social Influence (SN).

The results of both analyses conformed to the impact of Performance Expectancy or the relevance of the innovation to the task, and attested to the social nature of adoption. PE and SN each had nearly an equivalent impact on behavioural intention.

However, when it came to the size of the student enrolment, the results were totally different from expectations. Size was shown as having a nearly nil correlation with intent to use, and the path value was negative. This contradicted literature where Hoppe (2002) concluded firm size played a significant role in the adoption process, whereas the interviewees spoke of the impact that financial ability had on engaging in adoption projects.

According to the data, key determinants of analytics adoption in Ontario K-12 district school boards were: the value of the innovation as estimated by potential adopters; a good support structure composed of early adopters; and, peers and data professionals capable of providing assistance with technical and analytical difficulties encountered.

A strategy was deemed essential., with hints given as to the ultimate form of a desired strategy. Initially, the majority of participants called for a grassroots approach, later to realise a grassroots approach needed to be supplemented by a centralised commitment to sustain the adoption through the offer of resources under the sole control of the core functions of a school district, such as the data professionals. The situation arising from a potential threat to the continued existence of faith-based school districts from the current provincial government could help justify the benefits derived from more data-driven decisions. By presenting informed alternatives to further organisational

upheavals from amalgamations where not warranted, boards would in a better position to present a case supported by evidence.

On the last question relating to student body size, and against the evidence of the statistical results, the relevance of that factor in adoption was supported by the opposing evidence in the two school districts of dissimilar size, where some degree of organisational slack would permit adoption of an innovation aimed at surpassing the status quo. The researcher remained aware throughout the study that the work of educating students would be achieved with or without a formal analytics initiative. Consequently, analytics requires a suitable structure to prove useful, rather than represent a drain in resources.

Summary of Discussion

This chapter saw the main research question, and its three corollaries, addressed by a quantitative analysis of six hypotheses according to a statistical treatment based on structural equation modelling and, more precisely, partial least squares. A further investigation on qualitative evidence investigated three themes present in the research questions.

Although the inferential analysis supported only one hypothesis on the original endogenous variables of the UTAUT model, in combination with the interview analysis, the research questions received answers supported by evidence. The next chapter presents a summary of the research, addresses its limitations, and offers directions for future research on the subject.

Chapter V – CONCLUSION & DIRECTIONS FOR FUTURE RESEARCH

This research investigated the determinants for the use of analytics in Ontario K-12 districts school boards. Strategy, adoption, analytics and the relationship between these themes were investigated in the context of publicly-funded education. Analytics represents an idea, as well as an array of practical solutions, to elicit actionable insight from data for adding value to operations (ElAtia et al., 2012). The challenges identified by academic literature point to the complexity of implementing and managing the solution (J. P. Campbell & Oblinger, 2007), as well as the difficulty for end-users in gaining familiarity in its usage (Johnson, Adams, Estrada, & Freeman, 2015).

Overview of the Thesis

Chapter 1 gave a contextual overview of the issues with the adoption of analytics by Ontario school districts. Chapter 2 presented an extensive literature review on the primary and secondary education landscape in Ontario, three major themes, and theoretical frameworks used by scholars to understand adoption, including the TOE framework and the Unified Theory of Acceptance and Use of Technology (UTAUT). Chapter 3 provided a detailed account of the research method used for the study, including the data, the analysis, and a statement on the ethical research conducted. Chapter 4 examined the findings from the quantitative and qualitative analysis, exploring the question of analytics adoption by school districts. The chapter offered graphical representations of the data and statistical analysis, in addition to the interpretation of interview data. This chapter presents the limitations of the study and the contributions to current research, and proposes directions for future research.

Limitations of the Study

This research was impacted by limitations from three sources. The limitations involved the restrictions of access to data, time, and misunderstanding over what constitutes analytics. Despite the limitations, the research's contributions to the analytics literature and discipline remains substantial.

The first limitation concerned access to data. The Ontario Ministry of Education (MoE) expects school districts to focus on their mission of educating students, while performing their fiduciary duty to fiscal responsibility. A template was created by the MoE for districts to evaluate research projects and to favour matters showing a direct impact on student achievement. Many larger school districts, with the means to administer these functions, availed themselves of this provincial policy regarding research. Smaller districts left the matter to the discretion of their top executive. Districts were given the authority to decide which research projects they wished to support. Policies were also put in place to prevent any direct access by school district staff without explicit permission from the district. Therefore, research by external researchers, and on management issues in particular, occupies a distant place in the order of priorities for school districts. This situation contributed to an environment where interest in the topic of this research was difficult to generate.

The second limitation was the window of opportunity open for participation, the results from only two participating school districts allowed the research goals to be met. However, the available pool of possible participants was limited and the number of actual respondents to the survey met, and exceeded, minimal thresholds late in the data collection, so a second round of recruitment was not possible. The school year cycle of 10

months, punctuated with periods of intense activity at the beginning and end of each semester, exams and holidays, left little time around regular operations to proceed with data collection. The number of days suitable for data collection in an academic year were limited and outside of the control of the researcher. The number of potential participants was reduced by the demands of an already full agenda. Results from this exploratory study would require confirmation from one or more other studies.

The third limitation was a misunderstanding of analytics. While participants had a general understanding of analytics, applications seen as examples of analytics were limited to academic analytics, and did not extend to either education data mining or learning analytics. While the information gathered from learning analytics would not fall within the primary responsibilities of a school principal, the vision shared by participants was a little truncated when considering analytics from an organisational perspective. In addition, the assumption by participants that analytics was already in place and used by them may, as stated above, have impacted the inferential analysis in a negative way, by reducing the variance on actual use.

Contributions to Current Research

The contributions of the research are presented below from their theoretical, methodological, and practical perspectives.

Theoretical contributions. The topic of adoption of analytics in Ontario K-12 schools had not been the subject of much research. This study offered theoretical contributions to research on adoptions in investigating the application of the UTAUT model and suggesting a revised specification for education, repeated from Figure 18 below as Figure 19. The revised model eliminated indicator variables and the FC

exogenous variable was found to be not statistically significant. The exploratory model presented in this study was original in affirming the significant role of school enrolment in analytics adoption in lessening the burden on leaders of a larger student body as indicated during the interviews.

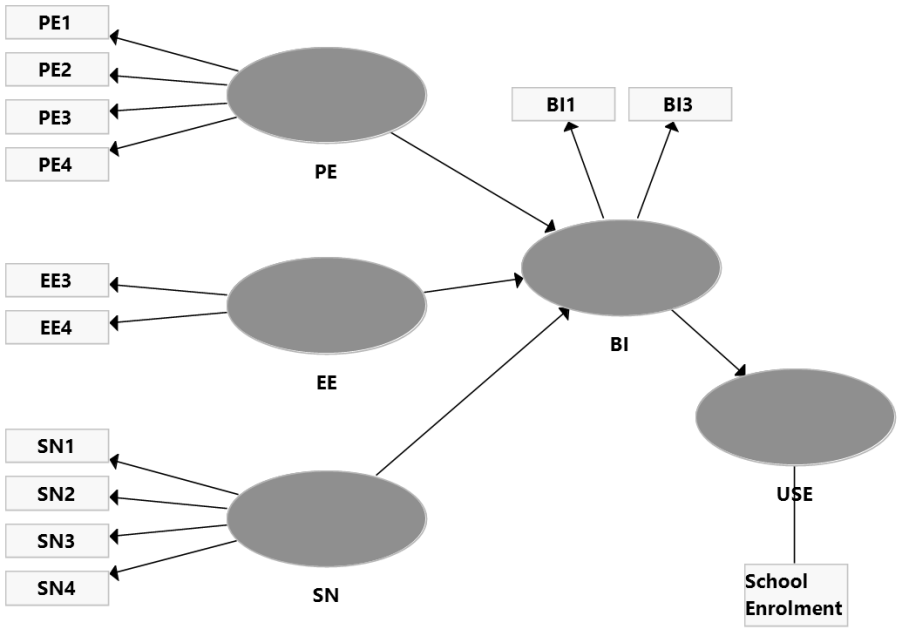

Figure 19. Proposed Revised Predictive Model

The study provided meaningful insights regarding the determinants of adoption in Ontario education. The study also established conditions viewed as necessary prerequisites in adopting analytics. Results of the research indicated that the predominant concern of the participants was for an innovation causing a minimum of additional effort, regardless of potential benefits. The study also questioned how UTAUT introduces facilitating conditions. Interviewees insisted on training, while training as part of facilitating conditions was not statistically significant in the survey data, likely due to the satisfaction with the support already received by the respondents to the survey. However, the study reinforced other aspects of the framework. The relationship between innovation

and the need for it to fulfill the function it purports to perform were supported, as well as with the impact that the opinions of social influencers of leaders in education plays in innovation.

The large portion of variance in behavioural intention, observed by Venkatesh et al. (2003) and explained by the UTAUT, held true in the study, with a combined path value in excess of 85 percent.

Methodological contributions. Using an instance of mixed methods or "between-method" rather than "within-method" triangulation (Jick, 1979), the study sought to improve the validity of results by using both a quantitative and qualitative method of analysis. The choice of combining a survey with interviews constituted a pragmatic decision to address the challenge presented by adequate local participation with low overall representation of the population at the provincial level. The aim was to provide the means to ensure the variance observed reflected the trait and was not an artefact of the method. Consistency and convergence on key points were observed between the two modes of investigation found in the study. Overall, the study provided a contribution to the understanding of technology adoption by presenting a new specification of the UTAUT model adapted for Ontario K-12 education.

Practical contributions. The initial intent of the research was to identify key determinants of analytics adoption in a specific segment of activity, primary and secondary education. That goal was achieved along with practical contributions to research in the field, which can be categorized into three parts.

Firstly, the research established the relevance of applying structural equation modelling, partial least squares in particular, to a management problem in education.

Extant literature had made extensive use of multiple linear regressions. PLS-SEM offers the benefits of the systematic application of a method unconcerned with the normality of the data collected and robust in handling smaller sample sizes. Although PLS-SEM is a common occurrence in research involving latent variables, including in technology adoption by students, its application to school district leaders is original.

Secondly, the study made contributions to the identification of a number of contributing determinants of analytics adoption in school districts.

- The main contributor likely to encourage adoption was *ease of use,* to minimise the amount of effort expended in using analytics. Therefore, the results suggested school districts should direct resources and efforts at the pre-adoption stage, ensuring that the selection of a specific analytics solution becomes an obvious choice.
- Extensive consultations with a large panel of potential users, including those with lower technical skills, would be advisable to address issues surrounding the *task-technology fit* (TTF) of analytics of concern to users.
- The development of a *strategy* around analytics was also identified as a key determinant of adoption. A grassroots approach regarding analytics to facilitate buy-in within the network of *social influence* among school principals needs to be strengthened and structured further with a strategy emanating from the district level, as the district controls central resources essential to sustained adoption.
- Consideration should be given to the *size* of a school district's *student body* and schools' *student enrolment*. At either level of analysis, the benefits of analytics will increase in step with the number of students. Size is also positively correlated to

matters of organisational slack and resources decisive in the analytics adoption decision-making, as well as sustaining the initiative.

Thirdly, the study also identified a number of incidental determinants that were of lesser importance for analytics adoption in school districts.

- The weak impact of facilitating conditions on adoption confirmed the assumptions of UTAUT in the statistical analysis. However, interviewees saw *support and training* as essential. The confusion may stem from the fact that new school district initiatives are invariably accompanied by training and support.
- The age of school principals also had an impact on the depth of their involvement with analytics, but did not result in a binary choice of use or do not use. Although not explicitly mandatory, use of analytics by school principals has become obligatory in order to attain the expected results of their role to promote student achievement. However, an individual's comfort level with innovations decreased with age and benefited from the assistance of an active social network.
- The concept of stage in a school leader's career, combining experience in the role and the number of years to retirement, played a similar role to the distinct concept of age discussed previously. School principals nearing retirement were considered less likely to invest time and efforts in gaining familiarity with innovations.
- The study avoided consideration of gender whenever possible. Gender was statistically not significant in the survey data. Regardless of the incumbent, the role of leader in education as an executive or school principal remains unchanged. Although attitudes towards adoption may vary based on gender, adoption is predicated by the requirements of the role of leader in education.

Future Research Directions

A revised UTAUT model, removing facilitating conditions, simplifying effort expectancy and behavioural intention to use, as well as replacing moderators by student enrolment, to evaluate the strength of the path values appears necessary. Along with data derived from further interviews, the researcher encourages future research to pursue the work on the appropriate specification for Ontario education. Future research would benefit from being conducted against a much larger sample, requiring the support and active collaboration of provincial authorities. This kind of research would demand a collegial approach between multiple researchers.

A number of research projects have concluded that there is no statistical significance of facilitating conditions unless moderated by age, gender, and experience. Given the difficulty of certain estimation methods to implement these moderating effects, a different specification of the UTAUT model should be envisioned if facilitating conditions are to remain as part of the *de facto* model.

Conclusion

The significance of this research is the identification of the factors affecting the adoption of analytics by senior leaders in Ontario's K-12 schools. Using a mixed methods approach, with data collected from two school districts from a survey and one-on-one interviews to identify determinants of adoption, the study found that, while student enrolment rates were a factor, the key determinants of adoption were mostly concerned with an easy user experience, meaningful results and wish to be consulted as part of adoption. Therefore, school districts considering how to implement analytics for administrative purposes, should define a strategy based on a revised UTAUT model that

focuses on frequent and extensive consultations with users impacted, as well as training, in order to maximise the impact of performance expectancy, effort expectancy, social influence, and behavioural intention to use on analytics adoption in K-12 education.

Glossary of Terms

Adoption: *Adoption* refers to the decision of any individual or organisation to make use of an innovation. Adoption is not a permanent decision (see discontinuance). (Frambach & Schillewaert, 2002)

Analytics: Learning *Analytics* is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs. (Siemens & Baker, 2012)

Diffusion: *Diffusion* refers to the accumulated level of users of an innovation in a market. It is the sum of the number of users of a given innovation and often is represented in the shape of an S-curve of number of adopters against time. After an initial slow uptake, the rate of adoption of a popular innovation will grow in rapidly and slow down again once saturation is reached. (Frambach & Schillewaert, 2002)

Discontinuance: Availability and awareness of a better innovation may lead to an end to the use of the innovation or *discontinuance* from replacement. Another form of discontinuance comes from disenchantment after an unsatisfactory period of use. (Rogers, 2003)

Higher learning: *Higher learning* is offered by colleges and universities and students decide to attend on their own and have to pay tuition fees. (Baer & Duin, 2014)

Innovation: An *innovation* can be an idea, practice, or object that is perceived as new by an individual or other unit of adoption. The expression “perceived as new by” is central to the concept of innovation. A new practice may have been around for a significant period of time and only becomes an innovation once the potential adopter becomes aware of it. (Rogers, 2003)

Ontario publicly-funded K-12 school districts: Publicly-funded K-12 school districts offer free primary and secondary education from Kindergarten to Grade 12. In Ontario, education has become mandatory for students until they are 18 years old or graduate high school. Many accommodations are made to allow students to earn credits. (Sattler, 2012)

Partial Least Squares: A family of techniques abbreviated into PLS is also referred to as Projection on Latent Structures (Vinzi, Chin, Henseler, & Wang, 2010).

TOE framework: The Technology, Organisational and Environmental Framework describes technology acceptance at the firm or organisational level. The TOE framework may explain, although not predict adoption (Wamba, 2015).

UTAUT: The Unified Theory of Acceptance and Use of Technology is a technology acceptance theory at the individual level. This theory seeks to predict actual technology use (Venkatesh et al., 2003).

REFERENCES

Abdi, H. (2010). Partial least squares regression and projection on latent structure regression (PLS Regression). *Wiley Interdisciplinary Reviews: Computational Statistics*, *2*(1), 97–106. https://doi.org/10.1002/wics.51

Abreu, A., & Acker, A. (2013). Context and collection : a research agenda for small data introduction : what big data leaves behind. In *iConference 2013 Proceedings* (pp. 549–554). https://doi.org/10.9776/13275

American Statistical Association. (2017). G Power 3.1 manual. *American Statistical Association*, *76*, 1–80. https://doi.org/10.1037/0096-1523.32.4.932

Andrews, R., & Johansen, M. (2012). Organizational environments and performance: a linear or nonlinear relationship? *Public Organization Review*, *12*, 175–189. https://doi.org/10.1007/s11115-012-0173-z

Awa, H. O., Ojiabo, O. U., & Emecheta, B. C. (2015). Integrating TAM, TPB and TOE frameworks and expanding their characteristic constructs for e-commerce adoption by SMEs. *Journal of Science & Technology Policy Management*, *6*(1), 76–94. https://doi.org/10.1108/JSTPM-04-2014-0012

Baer, L., & Duin, A. H. (2014). Retain your students! The analytics, policies and politics of reinvention strategies. *Planning for Higher Education*, *42*(3), 30–41.

Barnett, T., Pearson, A. W., Pearson, R., & Kellermanns, F. W. (2014). Five-factor model personality traits as predictors of perceived and actual usage of technology. *European Journal of Information Systems*, *in Press*(4), 1–17. https://doi.org/10.1057/ejis.2014.10

Baruch, Y. (1999). Response rate in academic studies - A comparative analysis. *Human*

Relations, *52*(4), 421–438. https://doi.org/0803973233

Bastian, K. C., McCord, D. M., Marks, J. T., & Carpenter, D. (2017). A temperament for teaching? Associations between personality traits and beginning teacher performance and retention. *AERA Open*, *3*(1), 233285841668476. https://doi.org/10.1177/2332858416684764

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, *13*, 544–559. https://doi.org/10.2174/1874434600802010058

Becker, J. (2017). Negative q2. Retrieved from http://forum.smartpls.com/viewtopic.php?t=15444

Bennett, N. (2008). Distributed leadership and IT. In J. Voogt & G. Knezek (Eds.), *International Handbook of Information Technology in Primary and Secondary Education* (Vol. 20, pp. 597–610). Springer. https://doi.org/10.1007/978-0-387-73315-90

Bentler, P. M. (2009). Alpha, dimension-free, and model-based internal consistency reliability. *Psychometrika*, *74*(1), 137–143. https://doi.org/10.1007/s11336-008-9100-1

Bezboruah, K. C., Paulson, D., & Smith, J. (2014). Management attitudes and technology adoption in long-term care facilities. *Journal of Health Organization and Management*, *28*, 344–365. https://doi.org/10.1108/JHOM-11-2011-0118

Bischoff, S., Aier, S., Haki, M. K., & Winter, R. (2015). Understanding continuous use of business intelligence systems: a mixed methods investigation. *JITTA : Journal of Information Technology Theory and Application*, *16*(2), 5–37.

Blackburn, H., & Blackburn, H. (2011). Millennials and the adoption of new technologies in libraries through the diffusion of innovations process. *Library Hi Tech*, *29*, 663–677. https://doi.org/10.1108/07378831111189769

Bolden, R. (2011). Distributed leadership in organizations: A review of theory and research. *International Journal of Management Reviews*, *13*(3), 251–269. https://doi.org/10.1111/j.1468-2370.2011.00306.x

Bollen, K. A., & Ting, K. F. (2000). A tetrad test for causal indicators. *Psychological Methods*, *5*(1), 3–22. https://doi.org/10.1037/1082-989X.5.1.3

Bowles, T. J., & Bosworth, R. (2002). Scale economies in public education: Evidence from school level data. *Journal of Education Finance*, *28*, 285–299.

Brown, S. A., Venkatesh, V., & Hoehle, H. (2015). Technology adoption decisions in the household: A seven-model comparison. *Journal of the Association for Information Science & Technology*, *66*(9), 1933–1949. https://doi.org/10.1002/asi.23305

Buabeng-Andoh Charles. (2012). Factors influencing teachers ' adoption and integration of information and communication technology into teaching : A review of the literature. *International Journal of Education and Development Using Information and Communication Technology*, *8*(1), 136–155.

Campbell, C., & Levin, B. (2009). Using data to support educational improvement. *Educational Assessment, Evaluation and Accountability*, *21*, 47–65. https://doi.org/10.1007/s11092-008-9063-x

Campbell, J. P., & Oblinger, D. G. (2007). Academic analytics. *Educause*, (October).

Chandler, A. D. (1962). *Strategy and structure: Chapters in the history of American enterprise*. Cambridge, MA: Massachusetts Institute of Technology Press.

Cho, E., & Kim, S. (2015). Cronbach's coefficient alpha: Well known but poorly understood. *Organizational Research Methods*, *18*(2), 207–230. https://doi.org/10.1177/1094428114555994

Codrington, S. (2014, May). Improving school board effectiveness: There is no alternative. *CSM Ideas*, 1–16.

Cook, T. D. (2002). Randomized experiments in educational policy research: A critical examination of the reasons the educational evaluation community has offered for not doing them. *Educational Evaluation and Policy Analysis*, *24*(3), 175–199.

Coombs, C. R., Doherty, N. F., & Loan-Clarke, J. (2001). The importance of user ownership and positive user attitudes in the successful adoption of community information systems. *Journal of Organizational and End User Computing*, *13*(4), 5–16. https://doi.org/10.4018/joeuc.2001100101

Cooper, A. (2012). *What is Analytics ? Definition and Essential Characteristics*. *CETIS Analytics Series* (Vol. 1). Bolton, UK.

Cooper, D. R., & Schindler, P. S. (2014). *Business research methods* (12th ed.). New York, NY, USA: McGraw-Hill Irwin.

Corbin, J., & Strauss, A. (1990). Grounded theory research: procedures, canons and evaluative criteria. *Qualitative Sociology*, *13*(1), 3–21. https://doi.org/10.1007/BF00988593

Corrigan, J. A. (2012). The implementation of e-tutoring in secondary schools: A diffusion study. *Computers and Education*, *59*, 925–936. https://doi.org/10.1016/j.compedu.2012.03.013

Crompton, H., & Keane, J. (2012). Implementation of a one-to-one iPod Touch program

in a middle school. *Journal of Interactive Online Learning*, *11*, 1–19.

Cronbach, L. J., & Hartmann, W. (1954). A note on negative reliabilities. *Educational and Psychological Measurement*, *14*(2), 342–346.

Croteau, J.-P. (2014). History of education in French-speaking Ontario : a historiographic review. *Canadian Issues*, (Spring), 23–30.

Davenport, T. H. (2006). Competing on analytics. *Harvard Business Review*, *84*(1), 98–107.

Davis, B. W., & Bowers, A. J. (2018). Examining the career pathways of educators with superintendent certification. *Educational Administration Quarterly*. https://doi.org/10.1177/0013161X18785872

Davis, F. D. (1986). *A technology acceptance model for empirically testing new end-user information systems: theory and results*. *PhD dissertation*. Massachusetts Institute of Technology.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319–340. https://doi.org/10.2307/249008

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, *35*, 982–1003.

Demiralp, Ç., Haas, P. J., Parthasarathy, S., & Pedapati, T. (2017). Foresight: Recommending visual insights. In *Proceedings of the VLDB Endowment* (pp. 1937–1940). https://doi.org/10.14778/3137765.3137813

Demirkan, H., & Delen, D. (2013). Leveraging the capabilities of service-oriented

decision support systems: Putting analytics and big data in cloud. *Decision Support Systems*, *55*(1), 412–421. https://doi.org/10.1016/j.dss.2012.05.048

Denney, A. S., & Tewksbury, R. (2013). How to Write a Literature Review. *Journal of Criminal Justice Education*, *24*, 219–234. https://doi.org/10.1080/10511253.2012.730617

DePietro, R., Wiarda, E., & Fleischer, M. (1990). The context for change: Organization, technology and environment. In L. G. Tornatzky & M. Fleischer (Eds.), *The processes of technological innovation* (pp. 151–175). Lexington, MA: Lexington Books.

Dhuey, E., & Smith, J. (2014). How important are school principals in the production of student achievement? *Canadian Journal of Economics*, *47*(2), 634–663. https://doi.org/10.1111/caje.12086

Dougherty, D., & Hardy, C. (1996). Sustained product innovation in large mature organisations: Overcoming innovation to organisation problems. *Academy of Management Journal*, *39*(5), 1120–1153.

Drees, J. M., & Heugens, P. P. M. A. R. (2013). Synthesizing and Extending Resource Dependence Theory: A Meta-Analysis. *Journal of Management*, *39*(6), 1666–1698. https://doi.org/10.1177/0149206312471391

Duncombe, W., Miner, J., & Ruggiero, J. (1995). Potential cost savings from school district consolidation: A case study of New York. *Economics of Education Review*, *14*(3), 265–284. https://doi.org/10.1016/0272-7757(94)00011-T

Dunn, R., Jaafar, S. Ben, Earl, L., & Katz, S. (2013). Towards data-informed decisions: From ministry policy to school practice. In K. Schildkamp, M. K. Lai, & L. Earl

(Eds.), *Data-based Decision Making in Education* (Electronic). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-4816-3

Dwivedi, Y. K., Rana, N. P., Jeyaraj, A., Clement, M., & Williams, M. D. (2017). Re-examining the Unified Theory of Acceptance and Use of Technology (UTAUT): Towards a Revised Theoretical Model. *Information Systems Frontiers*, 1–16. https://doi.org/10.1007/s10796-017-9774-y

Eisenhardt, K. M., & Santos, F. M. (2005). Organizational boundaries and theories of organization. *Organization Science*, *16*(5), 491–508.

ElAtia, S., Ipperciel, D., & Hammad, A. (2012). Implications and challenges to using data mining in educational research in the Canadian context. *Canadian Journal of Education*, *35*(2), 101–119.

EQAO. (2013). *Ontario's provincial assessment program - Its history and influence*. Toronto, ON.

EQAO. (2014). EQAO: School, board and provincial results. Retrieved July 25, 2014, from http://www.eqao.com

Eriksson, P., & Kovalainen, A. (2008). *Qualitative methods in business research*. London, UK: Sage Publications Ltd.

Farquhar, J. D. (2012). What is Case Study. In *Case Study Research for Business* (pp. 3–14).

Fichman, R. G. (1992). Information technology diffusion: a review of empirical research. *Proceedings of the Thirteenth International Conference on Information Systems (ICIS)*, (June), 195–206. https://doi.org/10.2307/249370

Fidan, T., & Oztürk, I. (2015). The Relationship of the Creativity of Public and Private

School Teachers to their Intrinsic Motivation and the School Climate for Innovation. *Procedia - Social and Behavioral Sciences*, *195*(October), 905–914. https://doi.org/10.1016/j.sbspro.2015.06.370

Fiedler, F. E. (1972). The effects of leadership training and experience: A contingency model interpretation. *Administrative Science Quarterly*, *17*(4), 453–470. https://doi.org/10.2307/2393826

Finn, J. D. (1997). Academic success among students at risk for school failure. *Journal of Applied Psychology Copyright*, *82*(2), 221–234. https://doi.org/10.1037/0021-9010.82.2.221

Forés, B., & Camisón, C. (2016). Does incremental and radical innovation performance depend on different types of knowledge accumulation capabilities and organizational size? *Journal of Business Research*, *69*(2), 831–848. https://doi.org/10.1016/j.jbusres.2015.07.006

Foster, S., Hawking, P., & Stein, A. (2005). Business Intelligence Solution Evolution: Adoption and Use. *Business Intelligence Journal*, *10*(4), 44–54.

Fraser Institute. (2010). How do Ontario schools compare? Retrieved July 25, 2014, from http://www.fraserinstitute.org

Galway, G., & Wiens, J. (2013). The impact of centralization on local school district governance in Canada. *Canadian Journal of Educational Administration and Policy*, *145*(2013), 1–34.

Gangwar, H., Date, H., & Ramaswamy, R. (2015). Understanding determinants of cloud computing adoption using an integrated TAM-TOE model. *Journal of Enterprise Information Management*, *28*(1), 107–130.

Gangwar, H., Date, H., & Raoot, A. D. (2014). Review on IT adoption: insights from recent technologies. *Journal of Enterprise Information Management*, *27*(4), 488.

Garcea, J. (2014). Reforms to funding education in four Canadian provinces. *Canadian Journal of Eucational Administration and Policy*, (159).

Garson, G. D. (2016). *Partial Least Squares: Regression & Structural Equation Models*. *G. David Garson and Statistical Associates Publishing*.

Gayle, G.-L., Golan, L., & Miller, R. A. (2015). Promotion, turnover, and compensation in the executive labor market. *Econometrica*, *83*(6), 2293–2369. https://doi.org/10.3982/ECTA11020

Gil-Flores, J., Rodríguez-Santero, J., & Torres-Gordillo, J. J. (2017). Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure. *Computers in Human Behavior*, *68*, 441–449. https://doi.org/10.1016/j.chb.2016.11.057

Gordon, S., Blake, R., & Shankaranarayanan, G. (2013). Case-based research in information systems: gaps and trends. *JITTA : Journal of Information Technology Theory and Application*, *14*(2), 47–66.

Government of Ontario, M. of F. (2015). Expenditure estimates of the province of Ontario for the fiscal year ending March 31, 2016 VOLUME 1. Retrieved May 27, 2015, from http://www.fin.gov.on.ca

Guster, D., & Brown, C. G. (2012). The application of business intelligence to higher education: Technical and managerial perspectives. *Journal of Information Technology Management*, *XXIII*(2), 42–62.

Hair, J. F., Hollingsworth, C. L., Randolph, A. B., & Chong, A. Y. L. (2017). An updated

and expanded assessment of PLS-SEM in information systems research. *Industrial Management & Data Systems*, *117*(3), 442–458. https://doi.org/10.1108/IMDS-04-2016-0130

Hair, J. F., Hult, G. T. M., Ringle, C., & Sarstedt, M. (2016). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. SAGE Publications.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a Silver Bullet. *The Journal of Marketing Theory and Practice*, *19*(2), 139–152. https://doi.org/10.2753/MTP1069-6679190202

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2012). Partial Least Squares: The Better Approach to Structural Equation Modeling? *Long Range Planning*, *45*(5–6), 312–319. https://doi.org/10.1016/j.lrp.2012.09.011

Hajtnik, T., Uglešić, K., & Živkovič, A. (2015). Acquisition and preservation of authentic information in a digital age. *Public Relations Review*, *41*, 264–271. https://doi.org/10.1016/j.pubrev.2014.12.001

Hambrick, D. C. (2007). Upper echelons theory: An update. *Academy of Management Review*, *32*(2), 334–343. https://doi.org/10.5465/amr.2007.24345254

Hannay, L., Jaafar, S. Ben, & Earl, L. (2013). A case study of district leadership using knowledge management for educational change. *Journal of Organizational Change Management*, *26*, 64–82. https://doi.org/10.1108/09534811311307914

Hargreaves, A., & Ainscow, M. (2015). The top and bottom of leadership and change. *Kappan*, 42–48.

Hargreaves, A., Shirley, D., Wangia, S., Bacon, C., & D'Angelo, M. (2018). *Leading from the middle: Spreading learning, well-being and identity across Ontario*.

Harris, A. (2003). Teacher leadership as distributed leadership: Heresy, fantasy or possibility? *School Leadership and Management*, *23*(3), 313–324. https://doi.org/10.1080/1363243032000112801

Hauptman, A. M. (2015). Taking a closer look at the OECD tertiary statistics. *International Higher Education*, *55*(8), 19–21. https://doi.org/10.1016/S0262-1762(10)70227-3

Hauseman, D. C. (2015). Publicly-reported indicators of school system success: a comparative study of three Canadian provinces. *Journal of Education and Training Studies*, *3*(4), 21–30. https://doi.org/10.11114/jets.v3i4.669

Hawking, P., & Sellitto, C. (2015). Business intelligence strategy: a utilities company case study. *International Journal of Enterprise Information Systems*, *11*(1), 1–12. https://doi.org/10.4018/ijeis.2015010101

Hazen, B. T., & Byrd, T. A. (2012). Toward creating competitive advantage with logistics information technology. *International Journal of Physical Distribution & Logistics Management*, *42*, 8–35. https://doi.org/10.1108/09600031211202454

Hellmer, E. (2015). *Authenticity in Electronic Archives :*

Herold, D. M., Jayaraman, N., & Narayanaswamy, C. R. (2006). What is the relationship between organizational slack and innovation? *Journal of Managerial Issues*, *18*(3), 372–392. https://doi.org/10.2307/40604546

Herzog, H. (2005). On home turf: Interview location and its social meaning. *Qualitative Sociology*, *28*(1), 25–47. https://doi.org/10.1007/s11133-005-2629-8

Holsapple, C., Lee-Post, A., & Pakath, R. (2014). A unified foundation for business analytics. *Decision Support Systems*, *64*, 130–141.

https://doi.org/10.1016/j.dss.2014.05.013

Hoppe, H. C. (2002). The Timing of New Technology Adoption: Theoretical Models and Empirical Evidence. *The Manchester School*, *70*(1), 56–76. https://doi.org/10.1111/1467-9957.00283

Hossain, M. A., & Quaddus, M. (2011). The adoption and continued usage intention of RFID: an integrated framework. *Information Technology & People*, *24*(3), 236–256. https://doi.org/10.1108/09593841111158365

Howard, R., Restrepo, L., & Chang, C. Y. (2017). Addressing individual perceptions: An application of the unified theory of acceptance and use of technology to building information modelling. *International Journal of Project Management*, *35*(2), 107–120. https://doi.org/10.1016/j.ijproman.2016.10.012

Hunter, D., & Dolmage, R. (2013). Fiduciary duty and school board takeovers in Canada since 1981: Fumbling toward a framework? *Education Law Journal*, *22*, 153–187.

Ibrahim, O., & Leong, L. W. (2012). Perception of information technology use in organization: Models and theories used in current landscape. *African Journal of Business Management*, *6*, 1290–1305. https://doi.org/10.5897/AJBM11.945

Ilie, V., Van Slyke, C., Green, G., & Lou, H. (2005). Gender differences in perceptions and use of communication technologies: A diffusion of innovation approach. *Information Resources Management Journal (IRMJ)*, *18*(3), 13–31.

Irvine, A., Drew, P., & Sainsbury, R. (2013). "Am I not answering your questions properly?" Clarification, adequacy and responsiveness in semi-structured telephone and face-to-face interviews. *Qualitative Research*, *13*(1), 87–106. https://doi.org/10.1177/1468794112439086

Jefferson, A. L. (2010). The impact of the economic crisis on elementary and secondary education funding: Ontario. *Management in Education*, *24*, 124–126. https://doi.org/10.1177/0892020608090410

Jeyaraj, A., Rottman, J. W., & Lacity, M. C. (2006). A review of the predictors, linkages, and biases in IT innovation adoption research. *Journal of Information Technology*, *21*, 1–23. https://doi.org/10.1057/palgrave.jit.2000056

Jiang, Y. (2009). A conceptual framework and hypotheses for the adoption of e-business intelligence. In *Computing, Communication, Control, and Management, 2009. CCCM 2009. ISECS International Colloquium on* (Vol. 4, pp. 558–561). https://doi.org/10.1109/CCCM.2009.5267534

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly*, *24*(4), 602. https://doi.org/10.2307/2392366

Jin, D., Chai, K.-H., & Tan, K.-C. (2012). Organizational adoption of new service development tools. *Managing Service Quality*, *22*(3), 233–259. https://doi.org/10.1108/09604521211230978

Johnson, L., Adams, S., Estrada, V., & Freeman, A. (2015). *NMC Horizon Report: 2015 K-12 Edition*. *Horizon Report*. Austin, TX: The New Media Consortium. https://doi.org/ISBN 978-0-9914828-5-6

Jwaifell, M., & Gasaymeh, A. (2013). Using the diffusion of innovation theory to explain the degree of English teachers ' adoption of interactive whiteboards in the modern systems school in Jordan : A case study. *Contemporary Educational Technology*, *4*, 138–149.

Kademeteme, E., Kalema, B. M., & Pretorius, P. (2017). Managing and improving data

quality through the adoption of data warehouse in the public sector. *African Journal of Science, Technology, Innovation and Development*, *9*(1), 31–41. https://doi.org/10.1080/20421338.2016.1258025

Kahma, N., & Matschoss, K. (2017). The rejection of innovations? Rethinking technology diffusion and the non-use of smart energy services in Finland. *Energy Research and Social Science*, *34*(February), 27–36. https://doi.org/10.1016/j.erss.2017.05.024

Kimmons, R. (2015). Online system adoption and K-12 academic outcomes. *Journal of Computer Assisted Learning*, *31*(4), 378–391. https://doi.org/10.1111/jcal.12101

Kissel, R., Regenscheid, A., Scholl, M., & Stine, K. (2014). *NIST Special Publication 800-88 Guidelines for Media Sanitization*. Gaithersburg, MD. https://doi.org/10.6028/NIST.SP.800-88r1

Kitchenham, B. A., & Plfeeger, S. L. (2008). Personal opinion surveys. In Springer (Ed.), *Guide to advanced empirical software engineering* (pp. 63–92). London, UK.

Ko, C., Pei, L., & Tsai, Y. (2016). A study of employees' perception of information technology adoption in hotels. *International Journal of Organizational Innovation (Online)*, *8*(3), 231–239.

Koehler, M. J., & Mishra, P. (2009). What is Technological Pedagogical Content Knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*. https://doi.org/10.1016/j.compedu.2010.07.009

Koehler, M., & Mishra, P. (2008). Introducing TPCK. In A. C. on Innovation & A. Technology (Eds.), *Handbook of Technological Pedagogical Content Knowledge (TPCK) for educators* (pp. 3–29). New York, NY, USA: Routledge.

Kondra, A. Z., & Hurst, D. C. (2009). Institutional processes of organizational culture. *Culture and Organization*, *15*(1), 39–58. https://doi.org/10.1080/14759550802709541

Kotsiantis, S. B. (2012). Use of machine learning techniques for educational proposes: a decision support system for forecasting students' grades. *The Artificial Intelligence Review*, *37*, 331–344. https://doi.org/10.1007/s10462-011-9234-x

Krueger, A. B., & Whitmore, D. M. (2001). The effect of attending a small class in the early grades on college-test taking and middle school test results: Evidence from Project STAR. *The Economic Journal*, *111*(468), 1–28.

Kuo, R.-Z., & Lee, G.-G. (2011). Knowledge management system adoption: exploring the effects of empowering leadership, task-technology fit and compatibility. *Behaviour & Information Technology*, *30*(1), 113–129. https://doi.org/10.1080/0144929X.2010.516018

Lacity, M. C., & Janson, M. A. (1994). Understanding qualitative data : A framework of text analysis methods. *Journal of Management Informations Systems*, (2), 137–155.

Leach, J., Payne, A. A., & Chan, S. (2010). The effects of school board consolidation and financing on student performance. *Economics of Education Review*, *29*, 1034–1046. https://doi.org/10.1016/j.econedurev.2010.05.003

Leadership Development Branch. (2011). *Supervisory officers - Certification, appointment and notice of suspension/dismissal*.

Lechman, E. (2013). New technologies adoption and diffusion patterns in developing countries. An empirical study for the period 2000-2011. *Equilibrium*, *8*(4), 79–106.

Leonard, P. S. J. (2015). Choice of Ontario high schools and student sorting by ability.

Applied Economics, *6846*(January), 1–22. https://doi.org/10.1080/09645292.2013.856869

Li, L. (2010). *A critical review of technology acceptance literature*. *Southwest Decisino Sciences Institute*. Grambling, LA.

Li, S. S. (2014). Telematics and informatics digital television adoption : Comparing the adoption of digital terrestrial television with the adoption of digital cable in Taiwan. *Telematics and Informatics*, *31*, 126–136. https://doi.org/10.1016/j.tele.2013.02.003

Li, X. (2015). Ontario education governance 1995 to the present: more accountability, more regulation, and more centralization? *Journal of International Education and Leadership*, *5*(1), 1–13.

Liu, Y. C., & Huang, Y.-M. (2015). Using the UTAUT model to examine the acceptance behavior of synchronous collaboration to support peer translation. *JALT CALL Journal*, *11*(1), 77–91.

Lundblad, J. P. (2003). A review and critique of Rogers' diffusion of innovation theory as it applies to organizations. *Organization Development Journal*, *21*(4), 50–64.

Lupart, J., & Webber, C. (2012). Canadian schools in transition: Moving from dual education systems to inclusive schools. *Exceptionality Education International*, *22*(2), 8–37.

Macfadyen, L. P., Dawson, S., Pardo, A., & Gašević, D. (2014). Embracing big data in complex educational systems: the learning analytics imperative and the policy challenge. *Research & Practice in Assessment*, *9*(2), 17–28.

Maclellan, D. (2007). The Fewer Schools Boards Act and the Toronto District School Board: Educational Restructuring 1997- 2003, 1–20.

Maharaj, S. (2014). Administrators' views on teacher evaluation: Examining Ontario's teacher performance appraisal. *Canadian Journal of Educational Administration and Policy*, (152), 1–58.

Mahesh, D. D., Vijayapala, S., & Dasanayaka, S. W. S. B. (2018). Factors Affecting the Intention to Adopt Big Data Technology A Study Based on Financial Services Industry of Sri Lanka. *2018 Moratuwa Engineering Research Conference (MERCon)*, 420–425.

Marangunic, N., & Granic, A. (2015). Technology acceptance model: a literature review from 1986 to 2013. *Universal Access in the Information Society*, *14*, 81–95. https://doi.org/10.1007/s10209-014-0348-1

Marshall, B., Cardon, P., Poddar, A., & Fontenot, R. (2013). Does sample size matter in qualitative research ?: a review of qualitative interviews in IS research. *Journal of Computer Information Systems*, *54*(1), 11–22. https://doi.org/10.1111/jan.12163.

Martínez-López, F. J., Esteban-Millat, I., Cabal, C. C., & Gengler, C. (2015). Psychological factors explaining consumer adoption of an e-vendor's recommender. *Industrial Management & Data Systems*, *115*, 284–310.

Maruping, L. M., Bala, H., Venkatesh, V., & Brown, S. A. (2017). Going beyond intention: Integrating behavioral expectation into the unified theory of acceptance and use of technology. *Journal of the Association for Information Science and Technology*, *68*(3), 623–637. https://doi.org/10.1002/asi

Mason, M. (2010). Sample size and saturation in PhD studies using qualitative interviews. *Forum: Qualitative Social Research*, *11*, 1–17.

Mathieson, K. (1991). Predicting user intentions: Comparing the technology acceptance

model with the theory of planned behavior. *Information Systems Research*, *2*(3), 173–191. https://doi.org/10.1287/isre.2.3.173

McKay, A., Byers, E. S., Voyer, S. D., Humphreys, T. P., & Markham, C. (2014). Ontario parents' opinions and attitudes towards sexual health education in the schools. *The Canadian Journal of Human Sexuality*, *23*, 159–166. https://doi.org/10.3138/cjhs.23.3-A1

Mcleod, G. T. (1984). The work of school board chief executive officers. *Canadian Journal of Education*, *9*(2), 171–190.

Mendes, M. V. I. (2018). The winding road of corporate strategy. *Revista Pensamento ContemporâNeo Em Administração*, *12*(1), 33. https://doi.org/10.12712/rpca.v12i1.1124

Mero-Jaffe, I. (2011). 'Is that what I Said?' Interview Transcript Approval by Participants: An Aspect of Ethics in Qualitative Research. *International Journal of Qualitative Methods*, *10*(3), 231–247. https://doi.org/10.1177/160940691101000304

Ministry of Education. (2011). Special Equipment Amount (SEA).

Mintzberg, H. (1987a). The Strategy Concept I: Five Ps For Strategy. *California Management Review*, *30*(1), 11–24.

Mintzberg, H. (1987b). The Strategy Concept II: Another Look at Why Organizations Need Strategies. *California Management Review*, *30*(1), 25–33.

Mintzberg, H. (1994). The fall and rise of strategic planning. *Harvard Business Review*, *27*(1), 90–115.

Moffett, S., & McAdam, R. (2006). The effects of organizational size on knowledge management implementation: Opportunities for small firms? *Total Quality*

Management and Business Excellence, *17*(2), 221–241. https://doi.org/10.1080/14783360500450780

Moghavvemi, S., Salleh, N. A. M., Sulaiman, A., & Abessi, M. (2015). Effect of external factors on intention–behaviour gap. *Behaviour & Information Technology*, *34*(12), 1171–1185. https://doi.org/10.1080/0144929X.2015.1055801

Moghawemi, S., & Akma Mohd Salleh, N. (2014). Effect of precipitating events on information system adoption and use behaviour. *Journal of Enterprise Information Management*, *27*, 599–622.

Moghawemi, S., Mohd Salleh, N. A., Zhao, W., & Mattila, M. (2012). The entrepreneur's perception on information technology innovation adoption: An empirical analysis of the role of precipitating events on usage behavior. *Innovation: Management, Policy and Practice*, *14*, 231–246. https://doi.org/10.5172/impp.2012.14.2.231

Moqbel, M., Charoensukmongkol, P., & Bakay, A. (2013). Are U.S. academics and professionals ready for IFRS? An explanation using technology acceptance model and theory of planned behavior. *Journal of International Business Research*, *12*(2), 47–60.

Mueller, R. (2011). Seeking election: Evaluating a campaign for public school board trusteeship. *Canadian Journal of Education*, *34*(3), 213–228.

Muhammad, A., Khan, A., Amin, N., & Lambrou, N. (2010). Drivers and barriers to business intelligence adoption: A case of Pakistan. In *European and Mediterranean Conference on Information Systems 2010* (Vol. 2010, pp. 1–23).

Neely, S. R. (2015). No child left behind and administrative costs: A resource dependence study of local school districts. *Education Policy Analysis Archives*, *23*, 26.

Neumerski, C. M. (2013). Rethinking instructional leadership, a review : What do we know about principal, teacher, and coach instructional leadership, and where should we go from here? *Educational Administration Quarterly*, *49*, 310–347. https://doi.org/10.1177/0013161X12456700

O'Reilly, M., & Parker, N. (2013). "Unsatisfactory saturation": a critical exploration of the notion of saturated sample sizes in qualitative research. *Qualitative Research*, *13*(2), 190–197. https://doi.org/10.1177/1468794112446106

OCDSB. (2018). Ottawa-Carleton District School Board. Retrieved from https://www.ocdsb.ca

OECD. (2015). Domestic product - Gross domestic product (GDP). Retrieved April 15, 2015, from https://data.oecd.org

Oliveira, T., & Martins, M. (2011). Literature review of information technology adoption models at firm level. *The Electronic Journal Information Systems Evaluation*, *14*(1), 110–121.

Ontario College of Teachers. (2018). Find a teacher. Retrieved July 15, 2018, from https://www.oct.ca/findateacher

Ontario Ministry of Education. (2011). Supervisory officers - A guide to legislative requirements and ministry procedures. Toronto, ON: Leadership Development Branch.

Ontario Ministry of Education. (2016). Policy/Program memorandum 159 - Collaborative professionalism. *Ontario Ministry of Education*, (159), 1–4.

OTPP. (2018). Ontario Teachers' Pension Plan. Retrieved July 15, 2018, from www.otpp.com

Oye, N. D., A.Iahad, N., & Ab.Rahim, N. (2014). The history of UTAUT model and its impact on ICT acceptance and usage by academicians. *Education and Information Technologies*, *19*(1), 251–270. https://doi.org/10.1007/s10639-012-9189-9

Papamitsiou, Z., & Economides, A. A. (2014). Learning analytics and educational data mining in practice: a systematic literature review of empirical evidence. *Journal of Educational Technology & Society*, *17*(4), 49–64.

Park, J., Gunn, F., Lee, Y., & Shim, S. (2015). Consumer acceptance of a revolutionary technology-driven product: The role of adoption in the industrial design development. *Journal of Retailing and Consumer Services*, *26*, 115–124. https://doi.org/10.1016/j.jretconser.2015.05.003

Petter, S., DeLone, W., & McLean, E. R. (2013). Information systems success: The quest for the independent variables. *Journal of Management Information Systems*, *29*(4), 7–62. https://doi.org/10.2753/MIS0742-1222290401

Pfeffer, J., & Salancik, G. R. (1978). *The external control of organizations: A resource dependence approach*. New York, New York, USA: Harper and Row Publishers.

Pfeffer, J., & Sutton, R. I. (2000). Knowing "what" to do is not enough: Turning knowledge into action. *California Management Review*, *42*(1), 83–108.

Picciano, A. G. (2012). The evolution of big data and learning analytics in American higher education. *Journal of Asynchronous Learning Networks*, *16*(3), 9–20.

Pichette, V., Boisvert, R., Monteith, S., & Kappel, C. (2013). *NOELights*. Terrace Bay, ON.

Pinto, L. E., Portelli, J. P., Rottmann, C., Pashby, K., Barrett, S. E., & Mujawamariya, D. (2012). Charismatic, competent or transformative? Ontario school administrators'

perceptions of "good teachers." *Journal of Teaching and Learning*, *8*(1).

Piotti, G. (2012). An institutional-cognitive perspective on headquarters-subsidiary conflicts: The case of German companies in China. *Critical Perspectives on International Business*, *8*(2), 136–156. https://doi.org/10.1108/17422041211230712

Pollock, K. (2013). Administrator and teachers' perceptions of school success in a publicly funded catholic school in Ontario, Canada. *Catholic Education: A Journal of Inquiry and Practice*, *16*, 309–334.

Popovič, A., Hackney, R., Coelho, P. S., & Jaklič, J. (2012). Towards business intelligence systems success: Effects of maturity and culture on analytical decision making. *Decision Support Systems*, *54*, 729–739. https://doi.org/10.1016/j.dss.2012.08.017

Puklavec, B., Oliveira, T., & Popovic, A. (2014). Unpacking business intelligence systems adoption determinants: An exploratory study of small and medium enterprises. *Economic and Business Review for Central and South - Eastern Europe*, *16*, 185–219.

Qasim, H., & Abu-Shanab, E. (2016). Drivers of mobile payment acceptance: The impact of network externalities. *Information Systems Frontiers*, *18*(5), 1021–1034. https://doi.org/10.1007/s10796-015-9598-6

Queen's Printer for Ontario. (2016a). Ontario public schools enrolment. Retrieved from https://www.ontario.ca/data/ontario-public-schools-enrolment

Queen's Printer for Ontario. (2016b). Quick facts: Ontario schools, 2013-14. Retrieved from http://www.edu.gov.on.ca/eng/general/elemsec/quickfacts/2013_2014.html

Queen's Printer for Ontario. (2018). Ontario public schools enrolment. Retrieved July 15,

2018, from https://www.ontario.ca/data/ontario-public-schools-enrolment

Ramamurthy, K. (Ram), Sen, A., & Sinha, A. P. (2008). An empirical investigation of the key determinants of data warehouse adoption. *Decision Support Systems*, *44*, 817–841. https://doi.org/10.1016/j.dss.2007.10.006

Rana, N. P., Williams, M. D., Dwivedi, Y. K., & Williams, J. (2012). Theories and theoretical models for examining the adoption of e-Government services. *E - Service Journal*, *8*(2), 26-56,107-108.

Ranjan, J., & Malik, K. (2007). Effective educational process: a data-mining approach. *VINE*, *37*(4), 502–515. https://doi.org/10.1108/03055720710838551

Rauscher, K. J., Casteel, Ã. C., & Bush, D. (2015). Factors affecting high school teacher adoption, sustainability, and fidelity to the "Youth@Work : Talking safety" curriculum, (June), 1–12. https://doi.org/10.1002/ajim.22497.

Reid, S. (2014). Knowledge influencers: leaders influencing knowledge creation and mobilization. *Journal of Educational Administration*, *52*, 332–357. https://doi.org/10.1108/JEA-01-2013-0013

Reinders, M., Frambach, R., & Kleijnen, M. (2015). Mandatory use of technology-based self-service: Does expertise help or hurt? *European Journal of Marketing*, *49*, 190–211. https://doi.org/10.1108/EJM-12-2012-0735

Reinhardt, R., Hietschold, N., & Gurtner, S. (2017). Overcoming consumer resistance to innovations - an analysis of adoption triggers. *R and D Management*, 1–16. https://doi.org/10.1111/radm.12259

Rice, R. E., & Rogers, E. M. (1980). Reinvention in the innovation process. *Knowledge*, *1*(4), 499–514.

Richardson, J. W., Beck, D., LaFrance, J., & McLeod, S. (2016). Job attainment and perceived role differences of cyberschool leaders. *Journal of Educational Technology & Society*, *19*(1), 211–222.

Rieber, L. P., & Welliver, P. W. . (1989). Infusing educational technology into mainstream educational computing. *International Journal of Instructional Media*, *16*(1), 21–32.

Ringle, C. M., Wende, S., & Becker, J.-M. (2015). SmartPLS Release: 3. Boenningstedt, Germany: SmartPLS GmbH.

Robertson, J. (2012). Likert-type scales, statistical methods, and effect sizes. *Communications of the ACM*, *55*(5), 6. https://doi.org/10.1145/2160718.2160721

Robertson, S. (2014). Declining enrolment in Ontario: what can history tell us and where do we go from here? *Canadian Journal of Educational Administration and Policy*, (164), 29.

Rogers, E. M. (1976). New product adoption and diffusion. *Journal of Consumer Research*, *2*(4), 290–301.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York, NY, USA: Free Press.

Rogers, P. L. (2000). Barriers to adopting emerging technologies in education. *Journal of Educational Computing Research*. https://doi.org/10.2190/4UJE-B6VW-A30N-MCE5

Rosseel, Y. (2016). The lavaan tutorial. Retrieved August 27, 2016, from http://lavaan.ugent.be/tutorial/tutorial.pdf

Royall, R. M., & Royall, R. M. (2016). The Effect of Sample Size on the Meaning of Significance Tests Published by : Taylor & Francis , Ltd . on behalf of the American

Statistical Association Stable URL : http://www.jstor.org/stable/2684616 REFERENCES Linked references are available on JSTOR f, *40*(4), 313–315.

Sahin, I. (2006). Detailed review of Rogers' diffusion of innovations theory and educational technology: Related studies based on Rogers' theory. *The Turkish Online Journal of Educational Technology*, *5*, 14–23.

Samithisomboon, S., & Chantatub, W. (2016). Perceptions of information technology processes among IT decision makers in Thailand. *International Journal of Business and Information*, *11*(1), 67–92.

Sang-Gun, L., Trimi, S., Kim, C., & Lee, S.-G. (2013). Innovation and imitation effects' dynamics in technology adoption. *Industrial Management & Data Systems*, *113*, 772–799. https://doi.org/10.1108/IMDS-02-2013-0065

Sattler, P. (2012). Education governance reform in Ontario: Neoliberalism in context. *Canadian Journal of Educational Administration and Policy*, *128*, 1–28.

Scheffel, M., Drachsler, H., Stoyanov, S., & Specht, M. (2014). Quality indicators for learning analytics. *Journal of Educational Technology & Society*, *17*(4), 117–132.

Schlesinger, P. A., & Rahman, N. (2015). Self service business intelligence resulting in disruptive technology. *The Journal of Computer Information Systems*, *56*(1), 11–21.

Schwarz, A., & Schwarz, C. (2014). An exploration of the individual-level post-adoption choice decision. *Journal of Information Technology Theory and Application*, *15*(3), 5–29.

Sheppard, B., & Brown, J. (2014). Leadership for a new vision of public school classrooms. *Journal of Educational Administration*, *52*(1), 84–96. https://doi.org/10.1108/JEA-03-2012-0027

Sheppard, B., Galway, G., & Brown, J. (2013). *School boards matter: Report of the pan-Canadian study of school district governance*. Montréal, QC, CAN: Canadian School Boards Association.

Shet, A., & Segrott, E. (2016). Teacher's irregularity and students performance: A causative analysis. *Science Insights*, *2016*(2016), 1–7. https://doi.org/10.15354/si.16.ar317

Siemens, G., & Baker, R. S. J. D. (2012). Learning analytics and educational data mining: towards communication and collaboration. In *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge* (pp. 252–254). New York, NY, USA: ACM. https://doi.org/10.1145/2330601.2330661

Sijtsma, K. (2009a). On the use, the misuse, and the very limited usefulness of cronbach's alpha. *Psychometrika*, *74*(1), 107–120. https://doi.org/10.1007/s11336-008-9101-0

Sijtsma, K. (2009b). Reliability beyond theory and into practice. *Psychometrika*, *74*(1), 167–173. https://doi.org/10.1007/s11336-008-9100-1

Simpson, S. H. (2015). Creating a data analysis plan: What to consider when choosing statistics for a study. *Canadian Journal of Hospital Pharmacy*, *68*(4), 311–317. https://doi.org/10.4212/cjhp.v68i4.1471

Singhal, A. (2012). Everett M. Rogers, an intercultural life: From Iowa farm boy to global intellectual. *International Journal of Intercultural Relations*, *36*, 848–856. https://doi.org/10.1016/j.ijintrel.2012.08.015

Solomon, M. R. (2014). *Consumer behavior: Buying, having, and being* (11th ed.). Engelwood Cliffs, NJ: Prentice Hall.

Somekh, B. (2008). Factors affecting teachers' pedagogical adoption of ICT. In J. Voogt & G. Knezek (Eds.), *International Handbook of Information Technology in Primary and Secondary Education* (pp. 449–460). Boston, MA: Springer US. https://doi.org/10.1007/978-0-387-73315-9_27

Souleles, N., Savva, S., Watters, H., & Annesley, A. (2014). Comparing student and faculty perceptions on the instructional value of iPads in art and design education. In N. Souleles & C. Pillar (Eds.), *Proceedings of the First International Conference on the use of iPads in Higher Education 2014* (pp. 208–217).

Spil, T. A. M., & Schuring, R. W. (2005). The UTAUT questionnaire items. In T. A. M. Spil & R. W. Schuring (Eds.), *E-Health Systems Diffusion and Use: The Innovation, the User and the USE IT Model* (pp. 93–98). Hershey PA, United States: IGI Global. https://doi.org/10.4018/978-1-59140-423-1.ch005

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage Publications, Inc.

Statistics Canada. (2018a). Census profile, 2016 Census. Retrieved September 11, 2018, from https://www12.statcan.gc.ca/census-recensement/2016

Statistics Canada. (2018b). Population and dwelling counts, for Canada, provinces and territories, and census divisions, 2016 and 2011 censuses. Retrieved September 9, 2018, from https://www12.statcan.gc.ca/census-recensement/2016

Statistics Canada [SC]. (2011). *Education indicators in Canada: An international perspective*. Ottawa.

Straumsheim, C. (2014). Dedoose crash shows dangers of handing data to cloud services. Retrieved January 24, 2016, from https://www.insidehighered.com

Swanson, B. E. (1994). Information Systems Innovation Among Organizations. *Management Science*, *40*(9), 1069–1092.

Swoyer, S. (2013). Increase BI Adoption by Embedding BI in Everyday Apps. Retrieved August 3, 2015, from http://tdwi.org

Troshani, I., Rampersad, G., & Plewa, C. (2011). Adopting innovation management software in university innovation commercialization. *The Journal of Computer Information Systems*, *52*(2), 83–92.

van Barneveld, A., Arnold, K., & Campbell, J. (2012). Analytics in higher education: Establishing a common language. *Educause Learning Initiative*, *1*, 1–11.

van Oorschot, J., Hofman, E., & Halman, J. (2015). A bibliometric review of the innovation adoption literature. In Academy of Management (Ed.), *Proceedings of the 75th Annual Meeting of the Academy of Management* (pp. 1–40). Vancouver, BC.

Venkatesh, V., & Brown, S. A. (2013). Research article bridging the qualitative–quantitative divide : Guidelines for conduction mixed methods. *MIS Quarterly*, *37*(1), 21–54.

Venkatesh, V., Brown, S. A., Maruping, L. M., & Bala, H. (2008). Predicting different conceptualizations of system use: The competing roles of behavioral intention, facilitating conditions and behavioral expectation. *MIS Quarterly*, *32*(3), 483–502.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425–478.

Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and user of information technology: Extending the unified theory of acceptance and use of technology. *MIS*

Quarterly, *36*, 157–178.

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2016). Unified theory of acceptance and use of technology: A synthesis and the road ahead. *Journal of the Association for Information Systems*, *17*, 328–376.

Vinzi, V. E., Chin, W. W., Henseler, J., & Wang, H. (2010). *Handbook of partial least squares: concepts, methods and applications*. (V. E. Vinzi, W. W. Chin, J. Henseler, & H. Wang, Eds.) (1st ed.). Springer Publishing Company, Incorporated.

Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2013). Technological pedagogical content knowledge - A review of the literature. *Journal of Computer Assisted Learning*, *29*(2), 109–121. https://doi.org/10.1111/j.1365-2729.2012.00487.x

Wamba, S. F. (2015). A conceptual framework of RFID adoption in retail using TOE framework, *5*(1), 1–38. https://doi.org/10.4018/IJTD.2015010101

West, D. (2012). *Big data for education: Data mining, data analytics, and web dashboards*. *Governance Studies at Brookings*.

Williams, C. K., & Karahanna, E. (2013). Causal explanation in the coordinating process: A critical realist case study of federated IT governances structures. *MIS Quarterly*, *37*(3), 933–964.

Wills, M. J. (2014). Decisions through data : Analytics in healthcare. *Journal of Healthcare Management*, *59*, 254–262.

Winton, S. (2013). How schools define success: the influence of local contexts on the meaning of success in three schools in Ontario, Canada. *Canadian and International Education*, *42*(1), 1–16.

Winton, S., & Pollock, K. (2013). Preparing politically savvy principals in Ontario, Canada. *Journal of Educational Administration*, *51*, 40–54. https://doi.org/10.1108/09578231311291422

Wisdom, J. P., Chor, K. H. B., Hoagwood, K. E., & Horwitz, S. M. (2014). Innovation adoption: A review of theories and constructs. *Administration and Policy in Mental Health and Mental Health Services Research*, *41*(4), 480–502. https://doi.org/10.1007/s10488-013-0486-4

Wixom, B. H., Ariyachandra, T., Douglas, D., Goul, M., Gupta, B., Iyer, L., … Turetken, O. (2014). The current state of business intelligence in academia: The arrival of big data. *Communications of the Association for Information Systems*, *34*, 1–13.

Wixom, B. H., Yen, B., & Relich, M. Maximizing value from business analytics., 12 MIS Quarterly Executive 111–123 (2013). MIS Quarterly Executive.

Yang, F., Harrison, L., Rensink, R. A., Franconeri, S., & Chang, R. (2018). Correlation judgment and visualization features: A comparative study. In *IEEE Transactions on Visualization and Computer Graphics* (Vol. X). https://doi.org/10.1109/TVCG.2018.2810918

Yang, H. "Chris," Liu, H., & Zhou, L. (2012). Predicting young Chinese consumers' mobile viral attitudes, intents and behavior. *Asia Pacific Journal of Marketing and Logistics*, *24*(1), 59–77. https://doi.org/10.1108/13555851211192704

Yazan, B. (2015). Three approaches to case study methods in education : Yin , Merriam , and Stake. *The Qualitative Report*, *20*(2), 134–152.

Yin, R. K. (2014). *Case study research: Design and methods*. (Amazon.Com, Ed.) (5th Electr). Thousand Oaks, CA: Sage Publications, Inc.

Zegarac, G., & Franz, R. (2007). *Secondary school reform in Ontario and the role of research, evaluation and indicator data*.

Zimpher, N. L. (1989). The RATE Project: A Profile of Teacher Education Students. *Journal of Teacher Education*, *40*(6), 27–30. https://doi.org/10.1177/002248718904000606

APPENDIX A - School Districts Policies Regarding External Research

	Enrolment			Number of Schools			
Name	K-8	9-12	Total	Elementary	Secondary	Total	Policy
Algoma District School Board	6,500	3,769	10,269	38	11	49	X
Algonquin and Lakeshore Catholic District School Board	7,685	4,190	11,875	36	6	42	X
Avon Maitland District School Board	10,251	6,130	16,381	38	10	48	X
Bluewater District School Board	11,303	5,523	16,826	41	11	52	X
Brant Haldimand Norfolk Catholic District School Board	6,292	3,512	9,804	30	3	33	X
Bruce-Grey Catholic District School Board	2,500	1,354	3,854	11	2	13	X
Catholic District School Board of Eastern Ontario	8,618	4,396	13,014	40	10	50	X
Conseil des écoles publiques de l'Est de l'Ontario	9,482	3,812	13,294	32	14	46	
Conseil scolaire de district catholique Centre-Sud	12,082	2,991	15,073	26	8	34	X
Conseil scolaire de district catholique de l'Est ontarien	7,233	3,284	10,517	45	14	59	
Conseil scolaire de district catholique des Aurores boréales	631	106	737	15	8	23	
Conseil scolaire de district catholique des Grandes Rivières	4,242	2,055	6,297	29	11	40	
Conseil scolaire de district catholique du Centre-Est de l'Ontario	16,304	4,845	21,149	50	10	60	X
Conseil scolaire de district catholique du Nouvel-Ontario	5,151	1,812	6,963	28	10	38	X
Conseil scolaire de district catholique Franco-Nord	1,996	880	2,876	13	3	16	
Conseil scolaire catholique Providence (formerly Conseil scolaire de district des écoles catholiques du Sud-Ouest)	7,535	1,599	9,134	26	8	34	
Conseil scolaire Viamonde (formerly Conseil scolaire de district du Centre Sud-Ouest)	8,495	1,672	10,167	45	14	59	X
Conseil scolaire de district du Grand Nord de l'Ontario	1,610	661	2,271	15	8	23	X
Conseil scolaire de district du Nord-Est de l'Ontario	1,545	509	2,054	9	6	15	
District School Board of Niagara	24,158	12,960	37,118	88	20	108	X
District School Board Ontario North East	4,360	3,283	7,643	23	10	33	
Dufferin-Peel Catholic District School Board	50,137	33,351	83,488	123	26	149	X
Durham Catholic District School Board	14,590	7,734	22,324	38	8	46	X
Durham District School Board	46,947	22,359	69,306	107	20	127	X
Grand Erie District School Board	17,568	9,776	27,344	59	14	73	X
Greater Essex County District School Board	24,055	12,059	36,114	59	17	76	X
Halton Catholic District School Board	20,950	10,347	31,297	43	10	53	X
Halton District School Board	42,692	18,670	61,362	84	27	111	X
Hamilton-Wentworth Catholic District School Board	18,679	10,975	29,654	48	8	56	X

Hamilton-Wentworth District School Board	34,319	16,305	50,624	95	21	116	X
Hastings & Prince Edward District School Board	10,192	5,365	15,557	40	9	49	X
Huron Perth Catholic District School Board	3,080	1,418	4,498	16	2	18	
Huron-Superior Catholic District School Board	3,548	1,393	4,941	20	3	23	
Kawartha Pine Ridge District School Board	21,681	11,569	33,250	76	17	93	X
Keewatin-Patricia District School Board	2,791	2,243	5,034	17	6	23	X
Kenora Catholic District School Board	1,162	404	1,566	5	1	6	
Lakehead District School Board	6,049	3,445	9,494	25	5	30	X
Lambton Kent District School Board	14,736	8,167	22,903	54	13	67	X
Limestone District School Board	13,205	7,431	20,636	50	12	62	X
London District Catholic School Board	11,866	7,306	19,172	45	9	54	X
Near North District School Board	6,586	3,664	10,250	36	7	43	
Niagara Catholic District School Board	14,947	7,686	22,633	51	8	59	X
Nipissing-Parry Sound Catholic District School Board	2,038	870	2,908	12	1	13	
Northeastern Catholic District School Board	1,863	426	2,289	13	1	14	X
Northwest Catholic District School Board	1,328		1,328	6		6	
Ottawa Catholic District School Board	25,453	14,267	39,720	80	16	96	X
Ottawa-Carleton District School Board	47,964	24,319	72,283	117	31	148	X
Peel District School Board	110,478	44,174	154,652	205	42	247	
Peterborough Victoria Northumberland and Clarington Catholic District School Board	9,562	4,715	14,277	31	6	37	X
Rainbow District School Board	8,521	5,198	13,719	36	10	46	
Rainy River District School Board	1,776	1,170	2,946	11	3	14	X
Renfrew County Catholic District School Board	3,622	1,063	4,685	21	2	23	
Renfrew County District School Board	5,788	3,707	9,495	24	8	32	X
Simcoe County District School Board	34,821	16,887	51,708	87	23	110	X
Simcoe Muskoka Catholic District School Board	13,361	7,309	20,670	41	9	50	
St Clair Catholic District School Board	6,239	2,718	8,957	26	2	28	
Sudbury Catholic District School Board	4,149	2,111	6,260	17	4	21	X
Superior North Catholic District School Board	747		747	9		9	
Superior-Greenstone District School Board	805	841	1,646	11	5	16	
Thames Valley District School Board	50,635	24,471	75,106	133	30	163	X
Thunder Bay Catholic District School Board	5,630	2,330	7,960	18	2	20	X
Toronto Catholic District School Board	60,484	30,631	91,115	171	39	210	X
Toronto District School Board	172,894	79,710	252,604	474	118	592	X
Trillium Lakelands District School Board	10,774	6,549	17,323	40	8	48	
Upper Canada District School Board	17,882	10,481	28,363	82	24	106	X
Upper Grand District School Board	21,968	11,813	33,781	61	13	74	X
Waterloo Catholic District School Board	14,652	6,856	21,508	45	5	50	X

Waterloo Region District School Board	42,103	20,634	62,737	103	17	120	X
Wellington Catholic District School Board	5,527	2,602	8,129	17	4	21	
Windsor-Essex Catholic District School Board	13,763	8,125	21,888	38	10	48	X
York Catholic District School Board	37,319	18,363	55,682	89	16	105	X
York Region District School Board	82,227	38,860	121,087	171	32	203	X
Total			2,014,336			4879	

Note: No policy indicates none was found on the district school board public-facing corporate web site. An internal policy might exist which is not publicised.

APPENDIX B - Survey Questions

Analytics for Educators

Introduction

We are interested in how people in education use various tools to analyze information for decision making purposes. Specifically, we are interested in whether or not educators are making use of analytics. Analytics is a process that involves the use of various techniques, including statistical analyses and modeling, to explain or predict outcomes. Analytics aim to provide insight into data for use by decision-makers and can take many forms including dashboards that provide a visual representation. Usually, the analytical tools come from external suppliers and may be proprietary. They would be add-ons to a general-purpose application such as a Student Information Systems (e.g., Trillium or PowerSchool). Names of some analytics tools familiar to educators are Compass for Success or IBM Watson.

Some school boards in Ontario have moved to make analytical tools available to principals and senior administrators. Your board may or may not have embraced this practice. We are interested in your opinions about the use of analytics regardless of whether your board is currently using any specific analytical tool.

Please answer the following questions with respect to your use of analytics for decision-making purposes. It should take about 10 minutes. All answers will be kept confidential and no person or school board will be identified based on your answers. Thank you in advance for participating in this survey.

Notes:

The completion of the questionnaire and its submission are viewed as your consent to participate. The survey data will be initially collected and stored on a server in the U.S. and is subject to access under the US Patriot Act until it is transferred from that server to the researcher's computer.

* 1. Current Assignment

Please choose the role that best defines your current assignment

I am a(n)

- ◯ elementary classroom teacher
- ◯ secondary classroom teacher
- ◯ department head
- ◯ resource support teacher
- ◯ vice principal elementary
- ◯ vice principal intermediate/secondary
- ◯ principal elementary
- ◯ principal intermediate/secondary
- ◯ guidance, coop teacher or SST
- ◯ superintendent

* 2. My school has

◯ less than 200 students	◯ more than 800 students
◯ 200-450 students	◯ N/A
◯ 450-800 students	

3. Use of Analytics

You will recall that analytics is a process that makes use of tools to help understand data. Please indicate whether or not you are familiar with any of the following analytical tools.

Analytics tools

	I am familiar with	I am not familiar with	I am
Dashboards (Dreambox, RazKids)	◯	◯	◯
e-Compass for Success	◯	◯	◯
EQAO Data Tool	◯	◯	◯
Excel - KPI Charts	◯	◯	◯
IBM Watson	◯	◯	◯
Ministry of Education: Board Interface Tools	◯	◯	◯
	◯	◯	◯

4. If you are familiar with any of the tools listed above, please indicate how often it is used.

◯ I do not use any of the tools listed ◯ I use the tools once a

◯ I use the tools ◯ I use the tools twice

◯ I use the tools once a ◯ I use the tool once

◯ Other (please

* 5. Performance Expectations

Please indicate how the use of analytics impacts your work. Indicate N/A if you do not use analytics.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
I find analytics useful in my job.	○	○	○	○	○	○
Using analytics increases the chances of achieving things that are important to me.	○	○	○	○	○	○
Using analytics enables me to accomplish tasks more quickly.	○	○	○	○	○	○
Using analytics increases my productivity.	○	○	○	○	○	○

* 6. Learning Analytics

Please indicate the degree to which these statements would apply to you.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Learning to use analytics would be easy for me.	○	○	○	○	○
The results generated from analytics would be clear and understandable to me.	○	○	○	○	○
It would be easy for me to become skillfull at using analytics.	○	○	○	○	○
I would like to learn more about analytics.	○	○	○	○	○

7. Corporate Use of Analytics

Please indicate whether or not those around you encourage the use of analytics.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
People who are important to me think that I should use analytics.	○	○	○	○	○
People who influence my behaviour think that I should use analytics.	○	○	○	○	○
The use of analytics is encouraged by senior management.	○	○	○	○	○
In general, the organisation has supported the use of analytics.	○	○	○	○	○

* 8. Facilitating Conditions

Please indicate the degree to which any of the following issues impacts your use of analytics.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I have the resources necessary to use analytics.	○	○	○	○	○
I have the knowledge necessary to use analytics.	○	○	○	○	○
Analytics is not compatible with other systems I use.	○	○	○	○	○
A specific person (or group) is available for assistance with analytics difficulties.	○	○	○	○	○
The school board should mandate the use of analytics.	○	○	○	○	○

9. Future Use

If you are currently using analytics, please answer the following questions. Otherwise, skip to the next section.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I plan to continue using analytics in the future.	○	○	○	○	○
I try to use analytics in my daily routine.	○	○	○	○	○
I want to become more proficient with analytics.	○	○	○	○	○

* 10. Background

How long have you been in your current position?

○ less than 1 year ○ 8-15 years

○ 1-3 years ○ more than 15 years

○ 4-7 years

Please indicate your gender.

Age Range

○ < 30 ○ 41-50

○ 30-35 ○ 51-55

○ 36-40 ○ > 55

APPENDIX C – Comparison of Population and Survey Sample

Survey Respondents

Current Assignment	Frequency	Percent	Cumulative Percent
Vice-principal elementary	7	12.1	12.1
Vice-principal intermediate/secondary	13	22.4	34.5
Principal elementary	28	48.3	82.8
Principal intermediate/secondary	8	13.8	96.6
Supervisory Officer	2	3.4	100.0
Total	58	100.0	

Gender	Frequency	Percent	Cumulative Percent
Female	39	67.2	67.2
Male	19	32.8	100.0
Total	58	100.0	

Age Range	Frequency	Percent	Cumulative Percent
30-35	1	1.7	1.7
36-40	5	8.6	10.3
41-50	29	50.0	60.3
51-55	15	25.9	86.2
Over 55	8	13.8	100.0
Total	58	100.0	

Note: In this instance, the population consists of the leaders in education at two Ontario publicly-funded district school boards. The smaller school district had 32 leaders and the larger district had 162 for a total of 194 in July 2018. There was a total of 58 responses to a survey sent to both districts.

APPENDIX C – Comparison of Population and Survey Sample (continued)

Population

Current Assignment	Frequency	Percent	Cumulative Percent
Vice-principal Elementary	24	12.4	12.4
Vice-principal Intermediate/Secondary	49	25.3	37.6
Principal Elementary	86	44.3	82.0
Principal Intermediate/Secondary	22	11.3	93.3
Supervisory Officer	13	6.7	100.0
Total	194	100.0	

Gender	Frequency	Percent	Cumulative Percent
Female	128	66.0	66.0
Male	66	34.0	100.0
Total	194	100.0	

Age Range	Frequency	Percent	Cumulative Percent
30-35	1	.5	.5
36-40	17	8.8	9.3
41-50	84	43.3	52.6
51-55	47	24.2	76.8
Over 55	45	23.2	100.0
Total	194	100.0	

Note: In this instance, the population consists of the leaders in education at two Ontario publicly-funded district school boards. The smaller school district had 32 leaders and the larger district had 162 for a total of 194 in July 2018. There was a total of 58 responses to a survey sent to both districts.

APPENDIX D - Semi-structured Interview Questions

	Driving research question	Narrative question
Q1	What are the key determinants of analytics sustained adoption in Ontario K-12 district school boards?	What is your understanding of analytics in general, and the use of analytics, in particular? How did you hear about the use of analytics in education? What would you find appealing with analytics for your school board? Are there support services, or resources you would consider essential to introduce and use analytics in your school board? Please describe those. If your board were to adopt an analytics tool, such as Compass, how widely would you want to see analytics made available in your school board? What specific circumstances or challenges would prevent you from considering analytics in your school board?
Q2	To what extent is a strategy necessary for the successful adoption of analytics by these school boards?	What form would the introduction of analytics take in your school board? For example, could analytics be introduced as part of a grassroots movement in your school board? Would it require a centralised strategy? What would that strategy look like?
Q3	What strategies have been used for analytics adoption?	Assuming your board were to adopt an analytics tool, which approach and steps would you envision for the deployment of analytics in your school board?
Q4	To what extent does the size of a school board and student enrolment influence analytics adoption?	Analytics have assisted organisations on issues of understanding data, in suggesting likely outcomes (predictions), or addressing staffing shortages. From your understanding of analytics, is your school board facing these or other challenges where analytics might help? Would you consider the particular circumstances (location, enrolment) of your school board to favour or hinder analytics' adoption?

APPENDIX E - Athabasca Ethics Application

Student Application for Ethics Review (current)

Project Info.

File No: 22465
Project Title: Determinants of Analytics Adoption in K-12 Organisations
Principal Investigator: Mr. Patrick Yang (Faculty of Business\Doctorate in Business Administration)
Start Date: 2017/01/01
End Date: 2018/12/31
Keywords: technology innovation adoption,analytics

Project Team Info.

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Common Questions

1. 1. Project Description

#	Question	Answer
1.1	Provide a clear statement of the purpose and objectives of the project.	The purpose of this study is to determine factors that contribute to analytics adoption and use in K-12 organisations. The study will explore what knowledge is required to facilitate the adoption of a strategy on analytics within a district school board environment. This study will analyse the relevance of the Unified theory of acceptance and use of technology in this environment. It should also bring forth recurring themes in the adoption of technology by Ontario school districts. The objective is to inform future researchers and practitioners on strategies to promote sustained technology adoption in the K-12 context studied.
1.2	Comment on the significance of this research project in light of the existing body of knowledge (please include references and sources).	Reduction of gaps: - Analytics has been studied in higher learning. Research on the subject in primary and secondary education is less common. - Few studies on technology adoption in Ontario school district were found and none on analytics. Implications for social change: - Efficiency in informing public policy on education - Issue recommendations for future adopters to see a higher probability of success.
1.3	Describe how research results will be disseminated.	Final research report to be provided to AU|Distribution of executive summary to participants upon request
1.4	If 'other', please explain.	

1.5	State the research question(s) and/or any associated hypothesis or proposition.	The main research question is: What are the key determinants of analytics sustained adoption in Ontario K-12 district school boards? Peripheral (3) questions emerging from this key research question: i. To what extent is a strategy necessary for the successful adoption of analytics by these school boards? ii. What strategies have been used for analytics adoption? iii. To what extent does the size of a school board and student enrolment influence analytics adoption?
1.6	Provide a description of your research proposal including project objectives, background, scope, methods and procedures, etc. (restricted to 1000 words).	The purpose of this research project is to contribute to a greater understanding of adoption processes in K12 education organisations. Ontario publicly-funded district school boards are the focus of this project. The literature speaks of the transformative potential of analytics at all levels of education, including primary and secondary (Siemens & Baker, 2012). However, analytics in higher learning has received more attention than primary and secondary education (ElAtia, Ipperciel, & Hammad, 2012). Asino (2015) suggested innovative education technologies such as analytics offered greater benefits to higher education than K-12. This gap has prompted researchers to wonder if indicators designed for higher education of the effectiveness of analytics would remain the same when transposed to a secondary school setting (Scheffel, Drachsler, Stoyanov, & Specht, 2014). Another gap in the literature concerns the research dedicated to Ontario education in relation to analytics. Despite governmental funding of analytics initiative no account for the deployment of analytics in Ontario K-12 publicly-funded education could be found apart from the experience of the York Region District school board (Dunn, Jaafar, Earl, & Katz, 2013). As such, this research will address the following research question of identifying the key determinants of sustained adoption of analytics by Ontario district school boards. Three peripheral questions aim at defining the extent to which a strategy is necessary for successful adoption, the strategies used to achieve adoption, as well as the role played by the size of a school district in adoption. The methods by which these questions will be

		explored are a mixed method embedded case study. Participants will consist of school district superintendents in their role as executives and school principals at four Ontario school districts granting their permission for an external researcher to approach their staff. The four districts will be chosen among the top third and bottom third by student enrolment of school districts operating in English and French. This would break down into one large English board, one small English board, one large French board and finally one small French board. Quantitative data will be obtained from an electronic survey targeted at all potential participants (N=140). The survey instrument was validated by its originators (Venkatesh, Morris, Davis, & Davis, 2003) and used by multiple researchers since (Bischoff, Aier, Haki, & Winter, 2015; Harsono & Suryana, 2014; Jawadi, 2014; Spil & Schuring, 2005). Data collected will be processed through a structural model to establish measures of performance expectancy, effort expectancy, social influence, facilitating conditions, behavioural intention in order to predict actual use or adoption of analytics according to the Unified theory of acceptance and use of technology (UTAUT) proposed by Venkatesh, Morris, Davis, and Davis (2003). One-on-one interviews will allow for the collection of qualitative data from a superintendent and school principal at each of the four school districts. These 8 semi-structured interviews will allow me to identify themes relevant to the adoption of analytics in Ontario district school boards. Additional interviews may be organised according to need. The resulting analysis should provide indications on elements to encourage or discourage in order to achieve sustained adoption of analytics in other Ontario school boards and address two identified gaps in academic literature. Asino, T. I. (2015). The future of our field. TechTrends, 59(1), 20–30. http://doi.org/http://dx.doi.org/10.1007/s11528-014-0816-8 Bischoff, S., Aier, S., Haki, M. K., & Winter, R. (2015). Understanding continuous use of business intelligence systems: a mixed methods investigation. JITTA?: Journal of

		Information Technology Theory and Application, 16(2), 5–37. Dunn, R., Jaafar, S. Ben, Earl, L., & Katz, S. (2013). Towards data-informed decisions: From ministry policy to school practice. In K. Schildkamp, M. K. Lai, & L. Earl (Eds.), Data-based Decision Making in Education (Electronic). Dordrecht: Springer Netherlands. http://doi.org/10.1007/978-94-007-4816-3 ElAtia, S., Ipperciel, D., & Hammad, A. (2012). Implications and challenges to using data mining in educational research in the Canadian context. Canadian Journal of Education, 35(2), 101–119. Harsono, L. D., & Suryana, L. A. (2014). Factors Affecting the Use Behavior of Social Media Using UTAUT 2 Model. Proceedings of the First Asia-Pacific Conference on Global Business, Economics, Finance and Social Sciences, (August), 1–14. Jawadi, N. (2014). Facteurs- clés de l'adoption des systèmes d'information dans la grande distribution alimentaire?: une approche par l 'UTAUT (No. 2014–199). Paris, France. Scheffel, M., Drachsler, H., Stoyanov, S., & Specht, M. (2014). Quality indicators for learning analytics. Journal of Educational Technology & Society, 17(4), 117–132. Siemens, G., & Baker, R. S. J. D. (2012). Learning analytics and educational data mining: towards communication and collaboration. In Proceedings of the 2nd International Conference on Learning Analytics and Knowledge (pp. 252–254). New York, NY, USA: ACM. http://doi.org/10.1145/2330601.2330661 Spil, T. A. M., & Schuring, R. W. (2005). The UTAUT questionnaire items. In T. A. M. Spil & R. W. Schuring (Eds.), E-Health Systems Diffusion and Use: The Innovation, the User and the USE IT Model (pp. 93–98). Hershey PA, United States: IGI Global. http://doi.org/10.4018/978-1-59140-423-1.ch005 Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS Quarterly, 27(3), 425–478.
1.7	Describe procedures, treatment or activities that are above, or in addition to, standard practices in this project area (e.g. health-related procedures, curriculum enhancements, extra	N/A

	follow-ups, etc.). If not applicable, enter N/A.	
1.8	References and sources are cited WITHIN the responses to the above questions in this application and a full reference list is appended in the Attachments tab.	Yes

2. 2. Data Collection

#	Question	Answer
2.1	Will the researcher or project team be able to identify any of the participants at any stage of the project?	Yes
2.2	Will participants be recruited or their data be collected from Alberta Health Services or Covenant Health or a data custodian as defined in the Alberta Health Information Act?	No
2.3	The primary/raw data collected will (check all that apply):	Have all personal identifying information removed (anonymized)
2.4	If this project involves secondary use of data, list all original sources. If not, please enter N/A.	N/A
2.5	In research where total anonymity and confidentiality is sought but cannot be guaranteed (e.g., where participants talk in a group) how will confidentiality be achieved? If not applicable, please enter N/A.	N/A

3. 3. Data Identifiers

#	Question	Answer
3.1	Personal Identifiers: Will you be collecting - at any time during the project, including recruitment - any of the following (check all that apply):	Surname and First Name|Email Address|Age at time of data collection
3.2	If other, please describe.	Age within a 5-year span
3.3	Will you be collecting - at any time of the project, including recruitment of participants - any of the following (check all that apply):	None

3.4	If other, please describe.	
3.5	If you are collecting any of the above, provide a comprehensive rationale to explain why it is necessary to collect this information. If you are not, please enter N/A.	Theory used postulates age plays a role in explaining behaviour studied.
3.6	If identifying information will be removed at some point, when and how will this be done? If this is not applicable, please enter N/A.	The name of participants and their school district will be removed from interview transcripts.
3.7	Specify what identifiable information will be RETAINED once data collection is complete, and explain why retention is necessary. Include the retention of master lists that link participant identifiers with de-identified data.	I will need to maintain a master list of interview participants to match them to their school district for validation or possible clarification, and analysis purposes. That master list will be stored in a locked cabinet at my home office and destroyed once the project has ended.
3.8	Describe your plans to link the data in this project with data associated with other studies (e.g., within a data repository) or with data belonging to another organisation. If not applicable, please enter N/A.	N/A

4. 4. Data Confidentiality and Privacy

#	Question	Answer
4.1	How will confidentiality of the data be maintained? Describe how the identity of participants will be protected both during and after research.	Interview participants will be given a code.
4.2	How will the principal investigator ensure that all project personnel are aware of their responsibilities concerning participants' privacy and the confidentiality of their information?	N/A
4.3	Will identifiable data be transferred or made available to persons or agencies outside the research team?	No
4.4	If Yes, describe in detail what identifiable information will be released, to whom, why they need access, and under what conditions. What safeguards will be used to protect the identity of participants and	N/A

	the privacy of their data? If No, please enter N/A.	
4.5	Provide details if identifiable data will be leaving the institution, province, or country (eg. member of research team is located in another institution or country, etc.). If not applicable, please enter N/A	N/A

5. 5. Data Storage, Retention and Disposal

#	Question	Answer
5.1	Describe how research data will be stored (e.g., digital files, hard copies, audio recordings, other). Specify the physical location and how it will be secured to protect confidentiality and privacy. (For example, study documents will be kept in a locked filing cabinet and computer files will be encrypted, etc.). If not applicable, please enter N/A.	Research data will be stored on digital files and audio recordings. Encrypted data will be kept on a password-protected home computer and a backup maintained on digital media cards locked in a filing cabinet.
5.2	University policy requires that you keep your data for a minimum of 5 years following completion of the project. Specify any plans for future use of the data. If the data will become part of a data repository or if this project involves the creation of a research database or registry for future research use, please provide details. If not applicable, please enter N/A	N/A
5.3	If you plan to destroy your data after the obligatory 5 year retention period, describe when and how this will be done. Indicate your plans for the destruction of the identifiers at the earliest opportunity consistent with the conduct of the research. If not applicable, please enter N/A.	Files will be securely erased and the digital media cards physically destroyed.

6. 6. Participant Information

#	Question	Answer
6.1	Who are you studying? Describe the population that will be included in this project.	Sample will be drawn from the population of Executives and senior administrators in Ontario district school boards.

6.2	Describe the inclusion criteria for participants (e.g., age range, health status, gender, etc.). Justify the inclusion criteria (e.g. safety, uniformity, research methodology, statistical requirement, etc.).	The inclusion criteria will be based on position held at the time of the data collection. Age and gender will not be among criteria for inclusion.
6.3	Describe and justify the exclusion criteria for participants.	Other staff members in school districts are not in a position to influence behaviour in the organisation to the same extent.
6.4	Will you be interacting with human participants, (i.e., will there be direct contact with human participants, for this study)? Note: NO means there will be no direct contact with participants, chart reviews, secondary data, interaction, etc.	Yes
6.5	How many participants do you hope to recruit (including controls, if applicable)?	The potential sample size is 150 participants for the survey while the potential sample size for interviewees is 8 participants.
6.6	Of these recruits, how many are controls? (Possible answer: None, Half, Random, Unknown, or an estimate in numbers, etc.)	None
6.7	If this is a multi-site project, how many participants (including controls, if applicable) are expected to be enrolled by all investigators at all sites in the entire project? If not applicable, please enter N/A.	N/A
6.8	Provide a justification of sample size.	The sample size for survey responses is based on the number of executives and principals in school districts of interest. The sample size for interviewees is based on two participants from each of the four school districts.
6.9	Does the research specifically target aboriginal/indigenous groups or communities? If yes, please ensure you address all the questions under tab 19.	No

7. 7. Recruitment

#	Question	Answer

7.1	Describe how you will identify potential participants (please be specific as to how you will find potentially eligible participants).	Four school districts will be retained from those agreeing to participate. The majority of Ontario school districts must give permission for external researchers to approach their staff. In many cases, a submission package describing the research project and stating the research organisation, in this instance Athabasca University, has given ethics approval must be submitted and examined by the competent body within the district. As part of this study, one executive and all school principals will be invited to participate in the anonymous survey. For the interview, one school principal will be chosen in the order of positive responses indicating their interest. The superintendent directly involved with analytics in each school board will be approached to be the participating executive for both the survey and the interview. That executive might be responsible for internal research or information technology. When two executives fit the selection criteria equally, a superintendent responsible for schools will be preferred to a superintendent of business.
7.2	Once you have identified a list of potentially eligible participants, indicate how the potential participants' names will be passed on to the researchers (if applicable) AND how the potential participants will be approached about the research.	District school boards of interest include 2 English and 2 French boards. Two districts will belong to the top third of districts in student enrollment and two will be in the bottom third by student enrollment. An initial phone call to the district's office of the Director of Education will determine the most suitable superintendent. An e-mail of introduction to this superintendent will follow with an offer to discuss the superintendent's possible participation further over the phone. Depending on local procedures, an electronic mail message will be addressed to all principals in a participating district to invite them to participate in an anonymous survey. Alternatively, a flyer will be distributed by the office of the Director of Education to all principals. The

		message or flyer will invite school principals to indicate their interest in an interview. The principal selected will be the one sending the first response of interest. If the first interviewee withdraws or if additional information is required for the qualitative portion study, the second principal will be contacted. This pattern will be repeated until there is at least one principal's interview from each district.
7.3	How will people obtain details about the research in order to make a decision about participating? Select all that apply:	Potential participants will contact researcher(s)
7.4	Provide the locations where recruitment will occur (e.g., schools, shopping malls, clinics, etc.).	Schools and the district office
7.5	Will potential participants be recruited through pre-existing relationships with researchers (e.g., Will an instructor recruit students from his/her classes, or a physician recruit patients from his/her practice? Other examples may be employees, acquaintances, own children or family members, etc.)?	No
7.6	If Yes, identify the relationship between the researchers and participants that could compromise the freedom to decline participation (e.g. professor-student). How will you ensure that there is no undue pressure on the potential participants to agree to the study? If No, please enter N/A.	N/A
7.7	Outline any other means by which participants could be identified, should additional participants be needed (e.g., response to advertising such as flyers, posters, ads in newspapers, websites, email, listserves; pre-existing records or existing registries; physician or community organisation referrals; longitudinal study, etc.).	Web sites for all 72 Ontario district school boards provide the name of all superintendents and school principals. The location but not the e-mail address of principals is provided. The function of superintendents listed on websites does not make clear who the superintendent responsible for analytics is in a district, requiring an individual check at each district.

8. 8. Informed Consent Determination

#	Question	Answer
8.1	Describe who will provide informed consent for this project. Select all that apply. Additional information on the informed consent process is available at: http://www.pre.ethics.gc.ca/eng/policy-politique/initiatives/tcps2-eptc2/chapter3-chapitre3/#toc03-intro	All participants have capacity to give free and informed consent
8.2	If applicable, provide justification for requesting a Waiver of Consent (Minimal risk only, additional guidance available at: http://www.pre.ethics.gc.ca/eng/policy-politique/initiatives/tcps2-eptc2/chapter3-chapitre3/#toc03-1b). If not applicable, please enter N/A.	N/A
8.3	How is participant consent to be obtained, indicated and documented? Select all that apply:	Signed consent form|Explicit oral consent|Implied by overt action (i.e. completion of questionnaire)
8.4	If you are not using a "Signed consent form", explain how the project information will be communicated and participant consent will be obtained and documented. Provide details for EACH of the options selected above. If you are using a "Signed consent form", please enter N/A.	N/A
8.5	If consent will be obtained from an Authorized Representative, i.e. Third Party Consent, explain why participants lack capacity to give informed consent (e.g., age, mental or physical condition, etc.). If not applicable, please enter N/A.	Although districts must indicate their willingness to see their staff approached, final consent to participate remains with individual participants.
8.6	Will participants who lack capacity to give full informed consent be asked to give Assent?	No
8.7	Provide details. If applicable, attach a copy of assent form(s) in the Attachments Tab. If not applicable, please enter N/A.	N/A
8.8	In cases where participants (re)gain capacity to give informed consent during the project, how will they be asked to provide consent on their own behalf? If not applicable, please enter N/A.	N/A

8.9	What assistance will be provided to participants, or those consenting on their behalf, who have special needs (e.g., non-English speakers, visually impaired, etc.)?	None
8.10	If at any time a participant wishes to withdraw, end, or modify their participation in the research or certain aspects of the research, describe how their participation will be ended or changed.	Participants may withdraw from the electronic survey at any time before the final submission. Withdrawal of an anonymous submission will be impossible afterwards. Recording and notes from participants' interview who wish to withdraw from the study will be destroyed. Analysis based on this information will be redone.
8.11	Describe the circumstances and limitations of data withdrawal from the study, including the last point at which it can be done.	Survey data will be anonymous and data from a specific participant cannot be removed. Data extracted from interviews can be excluded only until complete anonymising of data.

9. 9. Group Research Dissemination

#	Question	Answer
9.1	Will this project involve any group(s) where non-participants are present? For example, classroom research might involve groups that include participants and non-participants. If Yes, complete the remaining questions in this tab. If No, move to next tab.	No
9.2	How will you ensure that non-participants are not included in the project? How will you ensure that data from non-participants are not used in the project?	URL for questionnaire will be disseminated only to participants. Interviews will be one-on-one.
9.3	During the recruitment process, how will you guard against peer pressure influencing an individual’s decision to participate or not?	Dealing with senior administrators and executives, such peer pressure would not apply.
9.4	How will you provide appropriate activities for non-participants?	N/A

10. 10. Risk Assessment and Benefit Analysis

#	Question	Answer
10.1	Provide your assessment of the risks that may be associated with this research.	Minimal Risk - research in which the probability and magnitude of possible

		harms implied by participation is no greater than those encountered by participants in those aspects of their everyday life that relate to the research (TCPS2)
10.2	Provide a description of potential physical risks and discomforts.	- The physical risks will NOT be greater than those encountered by the participants in everyday life
10.3	Provide a description of other risks and discomforts associated with the research e.g. health, cognitive, socio-economic).	- The risks will NOT be greater than those encountered by the participants in everyday life
10.4	Describe how you will manage and minimize risks and discomforts, as well as mitigate.	Promote a safe interview environment.
10.5	If your project has the potential to identify individuals that are upset, distressed, or disturbed, or individuals warranting medical attention, describe the arrangements made to try to assist these individuals. Explain if no arrangements have been made.	N/A
10.6	Other, please list and describe.	
10.7	Describe any potential benefits of the proposed research to the participants. If there are no benefits, state this explicitly.	Gain a better understanding of how to facilitate innovation adoption in their environment.
10.8	Describe the scientific and/or scholarly benefits of the proposed research.	Confirm theory's applicability to the school district environment.
10.9	Benefits/Risks Analysis: Describe the relationship of benefits to risk of participation in the research.	Benefits outweigh risks which are themselves negligible.

11. 11. Interviews, Focus Groups, Surveys and Question ...

#	Question	Answer
11.1	Are any of the questions potentially of a sensitive nature? If Yes, please enter details below. If No, please enter N/A.	N/A
11.2	If any data were released, could it reasonably place participants at risk of criminal or civil law suits? If Yes, provide justification for including such information in the project. If No, please enter N/A.	N/A

11.3	Will you be using audio/video recording equipment and/or other capture of sound or images for the project? If Yes, provide details and ensure Tab 20 is completed. If No, please enter N/A.	Yes, an audio recorder will be used during interviews.
11.4	Internet-based research: Will your interaction with humans occur in private spaces (e.g., members only chat rooms, social networking sites, email discussions, etc.)?	Yes
11.5	Will these interactions occur in public space(s) where you will post questions initiating and/or maintaining interaction with participants?	No
11.6	Describe how permission to use the site(s) will be obtained. If not applicable, please enter N/A.	N/A
11.7	If you are using a third party research tool, website survey software, transaction log tools, screen capturing software, or masked survey sites, how will you ensure the security of data gathered at that site? If not applicable, please enter N/A.	The website survey software will be operated from a server operated by the researcher. DATA WILL BE SECURED BY AN ADMINISTRATIVE PASSWORD KNOWN ONLY TO THE RESEARCHER. DATA WILL BE BACKED UP TO OFFLINE STORAGE AND DELETED FROM THE SERVER WEEKLY.
11.8	If you do not plan to identify yourself and your position as a researcher to the participants from the onset of the research project, explain why you are not doing so, at what point you will disclose that you are a researcher, provide details of debriefing procedures, if any, and if participants will be given a way to opt out. If not applicable, please enter N/A.	N/A
11.9	How will you protect the privacy and confidentiality of participants who may be identified by email addresses, IP addresses, and/or other identifying information that may be captured by the system during your interactions with these participants? If not applicable, please enter N/A.	THE WEBSITE SURVEY SOFTWARE OFFERS THE OPTION TO TURN OFF THE COLLECTION OF IP ADDRESSES. THIS OPTION HAS BEEN SELECTED. THE ORIGINATING IP ADDRESS OF THE PARTICIPANT IS NOT RELEVANT TO THIS STUDY.

12. 12. Use of Deception or Partial Disclosure

#	Question	Answer

12.1	Will deception or partial disclosure be employed in recruiting participants? If No, move to next tab.	No
12.2	Describe the information that will be withheld from, or the misinformation that will be provided to, the participants. If not applicable, please enter N/A.	
12.3	Provide rationale for withholding information.	
12.4	Indicate how and when participants will be informed of the concealment and/or deception. Describe the plans for debriefing the participants. Indicate when the participants will be debriefed, and describe the nature and extent of debriefing	

13. 13. Conflict of Interest

#	Question	Answer
13.1	Have you read the "Conflict of Interest in Research Policy" and related Procedures found in the Research section of the policy manual?	Yes
13.2	How will you ensure that all research team members will be apprised of the above-noted policy and procedures?	I am the sole member of the research team.
13.3	If there is a real, potential or perceived conflict of interest to be disclosed to the REB, please attach a separate document in the Attachments tab describing the conflict and how you will manage that conflict.	

14. 14. Research Methods and Procedures

#	Question	Answer
14.1	Some research methods prompt specific ethical issues. The methods listed below have additional questions associated with them in this application. This project will involve the following: Select all that Apply.	Interviews (e.g., in-person, telephone, email, chat rooms, etc.).|Surveys and Questionnaires (including internet surveys)
14.2	If other, describe.	

14.3	Is this project a Clinical trial? (i.e., any investigation involving participants that evaluates the effects of one or more health-related interventions on health outcomes)?	No
14.4	If you are using any tests in this project diagnostically, indicate the member(s) of the project team who will administer the measures/instruments. If not, please enter N/A.	N/A
14.5	If any test results could be interpreted diagnostically, how will these be reported back to the participants? If not applicable, please enter N/A.	N/A

15. 15. Research Locations and Other Approval

#	Question	Answer
15.1	List the locations of the proposed research, including recruitment activities. Provide name of institution or organisation, town, or province as applicable	Four Ontario school districts to be determined. Two English and two French districts which are not known at this point. The four districts will be recruited by following their admission process for external researchers outlined in their policies and procedures published on their websites. All surveys will occur electronically, while all telephone interviews will take place via telephone.
15.2	Are you using AU Resources or wanting to recruit participants from AU? If Yes, please provide details. If No, please enter N/A.	N/A
15.3	NOTE: If Yes to question 15.2, you will require Institutional Permission. Please consult the "Institutional Permission to Access Resources for Research Purposes" Policy and Procedures for further details http://ous.athabascau.ca/policy/#POI. The Research Ethics Officer will initiate the request for institutional permission on your behalf once ethical approval has been obtained.	
15.4	NOTE: University policy stipulates that no personal information of staff or students under the care and control of the	

	University will be released to a researcher directly. Researchers should consult with the Dean (or designate) or Department Head to obtain support for the research project and to gain departmental assistance to recruit participants, extract required data from University systems or access other required resources. When information or participants are being sought from more than one department or faculty, written support must be sought from the Associate Vice-President, Student & Academic Services.	

16. 16. Multi-Institution Review

#	Question	Answer
16.1	Does this project require ethical approval from another REB (or equivalent)? If No, move to next tab.	Yes
16.2	If Yes, has this project already received approval from another REB (or equivalent)?	No
16.3	Please list the institution(s) where ethical approval has been obtained or is pending. If approved, attach the approval memo in the Attachments Tab. If not applicable, please enter N/A.	None yet. In many instances, school districts expect the institution the researcher operates under (Athabasca University) to have granted approval or for approval to be pending BEFORE APPLYING TO THE DISTRICTS' INTERNAL REVIEW BOARDS. LARGER SCHOOL DISTRICTS TEND TO HAVE MORE ELABORATE POLICIES AND PROCEDURES IN PLACE AROUND EXTERNAL RESEARCHERS. THEIR COMMITTEES MEET FROM ONE TO FOUR TIMES DURING THE SCHOOL YEAR. SMALLER DISTRICTS MAY GIVE THE DIRECTOR OF EDUCATION AUTHORITY TO APPROVE EXTERNAL RESEARCH PROJECTS. SHOULD DISTRICT APPROVAL NOT BE SECURED IN THE SPRING OF 2017, IT SHOULD BE OBTAINABLE IN THE FALL OF 2017 OR THE WINTER OF 2018. COMPLETION OF THE PROJECT WOULD BE DELAYED BY NO MORE THAN A FEW MONTHS.

17. 17. Funding

#	Question	Answer
17.1	Will some organisation or person other than the researcher be providing cash funding or in-kind support to this research project? If No, move to next tab.	No
17.2	If funding approved, specify source(s).	
17.3	If funding pending, specify source(s).	
17.4	Describe any expectations, expressed or implicit, that arise from the funder-researcher relationship.	

18. 18. Reimbursements and Incentives

#	Question	Answer
18.1	Will you be providing expense reimbursements or offering an incentive for participating in this research? If No, move to next tab (19).	No, I will not be offering expense reimbursements or incentives.
18.2	If you are providing expense reimbursements, describe in detail the expenses for which participants will be reimbursed, the value of the reimbursements and the process (e.g. participants will receive a cash reimbursement for parking, at the rate of $x per visit for up to # of visits for a total value of $x). If not applicable, please enter N/A.	
18.3	If you will be collecting personal information to reimburse or pay participants, describe the information to be collected and how privacy will be maintained. If not applicable, please enter N/A.	
18.4	Will participants receive any incentives for participating in this research? Select all that apply:	
18.5	Provide details of the value, including the likelihood (odds) of winning for prize draws and lotteries. If not applicable, please enter N/A.	

18.6	Excluding prize draws, what is the maximum value of the incentives offered to an individual throughout the research?	
18.7	If incentives are offered to participants, they should not be so large or attractive as to constitute coercion. Justify the value of the incentives you are offering relative to your study population. If not applicable, please enter N/A.	

19. 19. Aboriginal/Indigenous Peoples

#	Question	Answer
19.1	If your research specifically involves aboriginal/indigenous peoples, please complete this section. If your research does not involve aboriginal/indigenous peoples, move on to the next tab (20).	No, my research does not involve aboriginal/indigenous peoples
19.2	If you will be obtaining consent from Elders, leaders, or other community representatives, provide details. If not applicable, please enter N/A.	
19.3	If leaders of the group will be involved in the identification of potential participants, provide details. If not applicable, please enter N/A.	
19.4	Provide details if: • property or private information belonging to the group as a whole is studied or used; • the research is designed to analyze or describe characteristics of the group, or • individuals are selected to speak on behalf of, or otherwise represent the group. If not applicable, please enter N/A.	
19.5	Provide information regarding consent, agreements regarding access, ownership and sharing of research data with communities.	
19.6	Provide information about how final results of the study will be shared with the participating community (e.g., via band office, special presentation, deposit in community school, etc). If not applicable, please enter N/A.	

19.7	Is there a research agreement with the community?	Not applicable
19.8	Provide details about the agreement or why an agreement is not in place, not required, etc. If not applicable, please enter N/A.	

20. 20. Sound or Image

#	Question	Answer
20.1	If your research involves sound or images, please complete this section. If your research does not involve sound or images, please move on to the next tab (21).	Yes, my research does involve sound or images
20.2	Explain if consent obtained at the beginning of the project will be sufficient to cover the use of sound or image data collected during the course of the project, or if it will be necessary to obtain consent at different times, for different stages of the project, or for different types of data. If not applicable, please enter N/A.	Consent for the recording of particpants will be requested at the beginning of each interview.
20.3	At what stage, if any, can a participant withdraw his/her material? If not applicable, please enter N/A.	A participant may require his/her material to be withdrawn prior to the anonymization of the identifiable data.
20.4	If you or your participants' audio- or video-records, photographs, or other materials artistically represent participants or others, what steps will you take to protect the dignity of those that may be represented or identified?	The submission of the transcript for validation by the participant provides participants with an opportunity to object to material participants may find objectionable.
20.5	Who will have access to this data? For example, in cases where you will be sharing sounds, images, or materials for verification or feedback, what steps will you take to protect the dignity of those who may be represented or identified?	Raw data will only be available to me and the transcription service. A TRANSCRIPTION CONFIDENTIALITY AGREEMENT IS AVAILABLE FROM THE TRANSCRIPTION SERVICE AND TRANSCRIBERS OPERATE UNDER A COMPANY NDA.
20.6	When publicly reporting data or disseminating results of your project (e.g., presentation, reports, articles, books, curriculum material, performances, etc) that include the sounds, images, or materials you have collected by	In the context of a dissertation, the material as reported will be reviewed by my co-supervisors.

	participants, what steps will you take to protect the dignity of those who may be represented or identified?	
20.7	What opportunities are provided to participants to choose to be identified as the author/creator of the materials created in situations where it makes sense to do so?	No such opportunity will exist. Participants' school boards will not be identified by name and participants remain anonymous.
20.8	If necessary, what arrangements will you make to return original materials to participants?	Original materials will be sent back to participants via courrier with tracking and recipient signature.

21. 21. Registries and Databases (including Biobanks)

#	Question	Answer
21.1	If your research involves registries and databases, please complete this section. If your research does not involve registries and databases please move on to the next tab (22).	No, my research does not involve registries and databases
21.2	Where will the databases be located? Specify if the database will be under Canadian or foreign jurisdiction. Note that data housed on US servers fall under the US Patriot Act. At a minimum, participants should be informed of this potential breach in confidentiality.	
21.3	Who will have access to the databases? How is that access determined?	
21.4	Specify if the biobank(s) will be located under Canadian or foreign jurisdiction	
21.5	If other, please provide details:	
21.6	Will identifying information be stored within the database?	
21.7	Will identifying information be forwarded to non-local registries?	
21.8	If the database is to be maintained locally, what steps have been taken to ensure the privacy and security of the database are upheld?	
21.9	Who is responsible for the database?	

21.10	Please explain standard operating procedures for the database management, use and access. Please append any documentation in the Attachments Tab.	

22. 22. Hazard Safety

#	Question	Answer
22.1	Does the proposed research involve human or animal pathogens or toxins or involve environmental impacts? If No, move to next tab (23).	No, my research does not involve human or animal pathogens or toxins / environmental impacts
22.2	If your research study involves human or animal pathogens or toxins, what is the risk group (as defined by the Public Health Agency of Canada)? http://canadianbiosafetystandards.collaboration.gc.ca/index-eng.php	
22.3	If your research study involves human or animal pathogens or toxins, what is the containment level (as defined by the Public Health Agency of Canada)?	
22.4	Will you be importing/exporting or transferring any infectious materials into the laboratory at Athabasca University?	
22.5	If Yes, to be authorized to carry out controlled activities in the AU Science Laboratory, you must contact the AU Biosafety Officer and Science Laboratory Manager at sciencelab@athabascau.ca to advise them what is being imported/exported or transferred, and when, including the Containment Level (which cannot be higher than Level 2). Any new research project in this regard requires a hazard assessment and the Science Laboratory must keep training records on file for all members of the research team.	
22.6	If you are not working with these materials at the Athabasca University Science Laboratory, where will you be working with the materials?	
22.7	Please append copies of any Biosafety Permits and/or Certificates in the Attachments tab.	

23. 23. Clinical Trials

#	Question	Answer
23.1	If your research involves Clinical Trials, please complete the questions in this	No, my research does not involve clinical trials

	section. If your research does not involve Clinical Trials, please move on to the next tab (24).	
23.2	Protocol number if applicable. If not applicable, please enter N/A	
23.3	Protocol Date if applicable. If not applicable, please enter N/A	
23.4	Clinical trials must be registered before participant recruitment can begin. Provide registry and registration number (e.g., clinicaltrials.gov) if applicable. If not applicable, please enter N/A.	
23.5	Is this an investigator-initiated clinical trial?	
23.6	Does the project involve any of the following?	
23.7	If other, please describe.	
23.8	Trial Phase: Check all that apply.	
23.9	If applicable, describe the provisions made to break the code of a double-blind study in an emergency situation, and indicate who has the code. If not applicable, please enter N/A.	
23.10	If applicable, provide justification for using placebo or no-treatment arm. If not applicable, please enter N/A.	
23.11	If applicable, describe the clinical criteria for withdrawing an individual participant from the project due to safety or toxicity concerns. If not applicable, please enter N/A.	

24. 24. Data Safety and Monitoring for Clinical Trials

#	Question	Answer
24.1	If your research involves clinical trials, please complete this section. If your research does not involve clinical trials, please move on to the next tab (25).	No, my research does not involve clinical trials
24.2	Check the one that most accurately reflects the plan for data safety and monitoring for this project:	

24.3	Describe data monitoring procedures while research is going on. Include details of planned interim analysis, Data Safety Monitoring Board, or other monitoring systems. If not applicable, please enter N/A.	
24.4	Summarize any pre-specified criteria for stopping or changing the project protocol due to safety concerns. If not applicable, please enter N/A.	

25. 25. Health and Biological Specimen Collection

#	Question	Answer
25.1	If your research involves health and biological specimen collection, please complete this section. If your research does not involve health and biological specimen collection, please move on to the next tab (26).	No, my research does not involve health and biological specimen collection
25.2	Indicate health or biological specimen(s) that will be collected (for example, body tissues or fluids, be specific). If none, please enter N/A.	
25.3	This project will involve the following (select all that apply):	
25.4	If other, please provide details:	
25.5	Explain how the specimen will be collected. If not applicable, please enter N/A	
25.6	Explain how the specimen will be stored and how long the specimens will be stored and where the specimen will be stored. If not applicable, please enter N/A.	
25.7	Specify all intended uses of collected specimen(s). If not applicable, please enter N/A.	

26. 26. Checklist

#	Question	Answer

26.1	In the Attachments Tab, please ensure that you have appended all of the applicable documents.	Letter of Initial Contact|Questionnaires, Cover Letters, Surveys, Tests, Interview Scripts etc
26.2	If other, please list:	

27. 27. Supervisor's Support

#	Question	Answer
27.1	I have added my supervisor as a signing authority in the APPROVALS tab.	
27.2	***DO NOT add your supervisor as a project team member.	
27.3	This application is pre-programmed to route to the following authority levels: 1) Other Signing Authority (Supervisor) and 2) Office of Research Ethics.	
27.4	To route your application to your supervisor (to review and approve), complete the APPROVALS tab. In the Approvals tab select your supervisor from the list of supervisors under the "Other Approvals" heading (note - you may have to scroll down on the page to find your supervisor). Click on the checkbox to the left of the supervisor's name and save. Once you "SUBMIT" your application, it will automatically be routed to your supervisor to review and approve.	
27.5	If you do not find your supervisor in the list of approvers, please contact the Research Ethics Office (rebsec@athabascau.ca or 780-675-6718) to have your supervisor added as a signing authority.	

Attachments

Doc / Agreement	Version Date	File Name	Description
Certification of Ethical Approval - AU	2017/12/07	Certification of Ethics	Ethics renewal

		Approval_file 22465_dec 7_17.docx	
Informed Consent - Consent Form		Yang - Online informed consent - Survey.docx	Informed consent to survey
Informed Consent - Consent Form	2017/02/07	Yang - Online informed consent - Interview 20170207.docx	Revised informed consent to interview
Informed Consent- Information Letter		Yang - Flyer.docx	Flyer for information to recruit participants to the study
Research Instruments - Questionnaire/Survey		Yang - Survey questions.docx	Questions for survey
Research Instruments - Questionnaire/Survey	2017/12/06	Yang - Analytics for Educators.pdf	This prototype is done in Google Forms to facilitate collaboration with a school district research officer. The final distribution will be done using SurveyMonkey.
Research Instruments - Unstructured Interview-Guiding Questions		Yang - Interview questions.docx	Questions for interviews

APPENDIX F - Participant Consent Form

Consent Form
Study on Technology Adoption
The information collected for this project is confidential and protected under the Municipal Freedom of Information and Protection of Privacy Act, 1989.
I have read and understood the request for my participation in the study of technology adoption.

☐ I volunteer to be interviewed.
☐ I give permission for the interview to be audiotaped.

This form is to be completed and returned to the school **ONLY** if I consent to participate in this research.
Name of staff member: *(please print)* _____ Date: _____
E-mail address for follow-up: *(please print)*
_____
Signature of staff member:
_____

APPENDIX G - AU ERB Certification of Ethics Approval

Athabasca University
RESEARCH CENTRE

CERTIFICATION OF ETHICAL APPROVAL

The Athabasca University Research Ethics Board (AUREB) has reviewed and approved the research project noted below. The AUREB is constituted and operates in accordance with the current version of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS) and Athabasca University Policy and Procedures.

Ethics File No.: **22465**

Principal Investigator:
Mr. Patrick Yang, Graduate Student
Faculty of Business\Doctorate in Business Administration

Supervisor:
Dr. Kay Devine (Co-Supervisor)
Dr. Andy Igonor (Co-Supervisor)

Project Title:
Determinants of Analytics Adoption in K-12 Organisations

Effective Date: February 09, 2017 **Expiry Date**: February 8, 2018

Restrictions:

Any modification or amendment to the approved research must be submitted to the AUREB for approval.

Ethical approval is valid *for a period of one year*. An annual request for renewal must be submitted and approved by the above expiry date if a project is ongoing beyond one year.

A Project Completion (Final) Report must be submitted when the research is complete *(i.e. all participant contact and data collection is concluded, no follow-up with participants is anticipated and findings have been made available/provided to participants (if applicable))* or the research is terminated.

Approved by: **Date:** February 9, 2017

Fathi Elloumi, Chair
Faculty of Business, Departmental Ethics Review Committee

Athabasca University Research Ethics Board
University Research Services, Research Centre
1 University Drive, Athabasca AB Canada T9S 3A3
E-mail rebsec@athabascau.ca
Telephone: 780.675.6718

APPENDIX G – AU ERB Certification of Ethics Approval (continued…)

Athabasca University
RESEARCH CENTRE

CERTIFICATION OF ETHICAL APPROVAL - RENEWAL

The Athabasca University Research Ethics Board (AUREB) has reviewed and approved the research project noted below. The AUREB is constituted and operates in accordance with the current version of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS) and Athabasca University Policy and Procedures.

Ethics File No.: **22465**

Principal Investigator:
Mr. Patrick Yang, Graduate Student
Faculty of Business\Doctorate in Business Administration

Supervisor:
Dr. Kay Devine (Co-Supervisor)
Dr. Andy Igonor (Co-Supervisor)

Project Title:
Determinants of Analytics Adoption in K-12 Organisations

Effective Date: December 7, 2017 **Expiry Date**: December 06, 2018

Restrictions:

Any modification or amendment to the approved research must be submitted to the AUREB for approval.

Ethical approval is valid *for a period of one year*. An annual request for renewal must be submitted and approved by the above expiry date if a project is ongoing beyond one year.

A Project Completion (Final) Report must be submitted when the research is complete *(i.e. all participant contact and data collection is concluded, no follow-up with participants is anticipated and findings have been made available/provided to participants (if applicable))* or the research is terminated.

Approved by: **Date:** December 7, 2017

Joy Fraser, Chair
Athabasca University Research Ethics Board

Athabasca University Research Ethics Board
University Research Services, Research Centre
1 University Drive, Athabasca AB Canada T9S 3A3
E-mail rebsec@athabascau.ca
Telephone: 780.675.6718

Appendix G – AU ERB Certification of Ethics Approval (continued…)

Athabasca University
RESEARCH CENTRE

CERTIFICATION OF ETHICAL APPROVAL - RENEWAL

The Athabasca University Research Ethics Board (AUREB) has reviewed and approved the research project noted below. The AUREB is constituted and operates in accordance with the current version of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS) and Athabasca University Policy and Procedures.

Ethics File No.: **22465**

Principal Investigator:
Mr. Patrick Yang, Graduate Student
Faculty of Business\Doctorate in Business Administration

Supervisor:
Dr. Andy Igonor (Co-Supervisor)

Project Title:
Determinants of Analytics Adoption in K-12 Organisations

Effective Date: November 21, 2018 **Expiry Date**: November 20, 2019

Restrictions:

Any modification or amendment to the approved research must be submitted to the AUREB for approval.

Ethical approval is valid *for a period of one year*. An annual request for renewal must be submitted and approved by the above expiry date if a project is ongoing beyond one year.

A Project Completion (Final) Report must be submitted when the research is complete *(i.e. all participant contact and data collection is concluded, no follow-up with participants is anticipated and findings have been made available/provided to participants (if applicable))* or the research is terminated.

Approved by: **Date:** November 21, 2018

Carolyn Greene, Chair
Athabasca University Research Ethics Board

Athabasca University Research Ethics Board
University Research Services, Research Centre
1 University Drive, Athabasca AB Canada T9S 3A3
E-mail rebsec@athabascau.ca
Telephone: 780.675.6718

APPENDIX H - Kurtosis and Skewness in Sample

Table 30

Kurtosis and Skewness

Variable	Excess Kurtosis	Skewness
CurrentAssignment	-0.01	-0.056
SchoolEnrolment	-0.9	0.035
Familiarity_Dashboards	0.763	-1.624
Familiarity_eCompass	1.248	1.663
Familiarity_EQAO_DataTool	58	-7.616
Familiarity_Excel_KPI_Charts	-1.619	0.588
Familiarity_IBM_Watson	6.647	2.808
Familiarity_MOE_Board_Interface_Tools	-1.72	0.068
Familiarity_Other	0.56	-0.014
FrequencyOfUse	0.338	0.205
P1	3.756	-1.897
P2	3.935	-1.892
P3	3.04	-1.246
P4	2.004	-1.267
E1	0.013	-0.389
E2	0.767	-0.091
E3	0.659	-0.693
E4	3.097	-1.127
S1	1.342	-0.598
S2	1.561	-0.809
S3	2.938	-1.078
S4	0.545	-0.357
F1	0.138	-0.651
F2	-0.578	-0.52
F3	-0.181	0.217
F4	0.016	-0.605
MandatoryUse	0.31	-0.458
B1	8.42	-1.717
B2	-0.746	0.213
B3	5.595	-1.38
TimeInCurrentPosition	-0.831	-0.117
Gender	-1.483	0.754
AgeRange	0.034	0.118

Note: Greyed values are outside the desired range of -1 to 1.

APPENDIX I. Frequency Distribution of Latent Variables Components

Table 31

Performance Expectations (PE)

	Answer	Count
Performance Expectations - I find analytics useful in my job	N/A	2
	Strongly Disagree	2
	Disagree	2
	Neutral	3
	Agree	29
	Strongly Agree	20
Performance Expectations - Using analytics increases the chances of achieving things that are important to me	N/A	2
	Strongly Disagree	2
	Disagree	2
	Neutral	4
	Agree	34
	Strongly Agree	14
Performance Expectations - Using analytics enables me to accomplish tasks more quickly	N/A	2
	Strongly Disagree	0
	Disagree	4
	Neutral	20
	Agree	25
	Strongly Agree	7
Performance Expectations - Using analytics increases my productivity	N/A	2
	Strongly Disagree	2
	Disagree	3
	Neutral	15
	Agree	26
	Strongly Agree	10

APPENDIX I. Frequency Distribution of Latent Variables Components

(continued…)

Table 32

Effort Expectancy (EE)

	Answer	Count
Effort Expectancy - Learning to use analytics would be easy for me	N/A	0
	Strongly Disagree	0
	Disagree	3
	Neutral	14
	Agree	31
	Strongly Agree	10
Effort Expectancy - The results generated from analytics would be clear and understandable to me	N/A	0
	Strongly Disagree	0
	Disagree	0
	Neutral	10
	Agree	42
	Strongly Agree	6
Effort Expectancy - It would be easy for me to become skillfull at using analytics	N/A	0
	Strongly Disagree	0
	Disagree	4
	Neutral	12
	Agree	36
	Strongly Agree	6
Effort Expectancy - I would like to learn more about analytics	N/A	0
	Strongly Disagree	1
	Disagree	1
	Neutral	9
	Agree	35
	Strongly Agree	12

APPENDIX I. Frequency Distribution of Latent Variables Components

(continued…)

Table 33

Social Influence (SN)

	Answer	Count
Social Influence - People who are important to me think that I should use analytics	N/A	0
	Strongly Disagree	1
	Disagree	2
	Neutral	21
	Agree	29
	Strongly Agree	5
Social Influence - People who influence my behaviour think I should use analytics	N/A	0
	Strongly Disagree	2
	Disagree	2
	Neutral	21
	Agree	28
	Strongly Agree	5
Social Influence - The use of analytics is encouraged by senior management	N/A	0
	Strongly Disagree	1
	Disagree	1
	Neutral	10
	Agree	35
	Strongly Agree	11
Social Influence - In general, the organisation has supported the use of analytics	N/A	0
	Strongly Disagree	0
	Disagree	1
	Neutral	10
	Agree	36
	Strongly Agree	11

APPENDIX I. Frequency Distribution of Latent Variables Components

(continued…)

Table 34

Facilitating Conditions (FC)

	Answer	Count
Facilitating Conditions - I have the resources necessary to use analytics	N/A	0
	Strongly Disagree	0
	Disagree	6
	Neutral	13
	Agree	34
	Strongly Agree	5
Facilitating Conditions - I have the knowledge necessary to use analytics	N/A	0
	Strongly Disagree	0
	Disagree	9
	Neutral	17
	Agree	30
	Strongly Agree	2
Facilitating Conditions - Analytics is not compatible with other systems I use	N/A	0
	Strongly Disagree	2
	Disagree	27
	Neutral	25
	Agree	4
	Strongly Agree	0
Facilitating Conditions - A specific person (or group) is available for assistance with analytics difficulties	N/A	0
	Strongly Disagree	1
	Disagree	8
	Neutral	16
	Agree	29
	Strongly Agree	4

APPENDIX I. Frequency Distribution of Latent Variables Components

(continued…)

Table 35

Behavioural Intention (BI)

	Answer	Count
Future Use - I plan to continue using analytics in the future	N/A	0
	Strongly Disagree	1
	Disagree	0
	Neutral	5
	Agree	43
	Strongly Agree	9
Future Use - I try to use analytics in my daily routine	N/A	0
	Strongly Disagree	2
	Disagree	21
	Neutral	18
	Agree	15
	Strongly Agree	2
Future Use - I want to become more proficient with analytics	N/A	0
	Strongly Disagree	1
	Disagree	0
	Neutral	6
	Agree	38
	Strongly Agree	13

APPENDIX J - Indicator Exclusions in EE

With EE1 removed

Latent Variable	Indicators	Convergent Validity			Internal Consistency Reliability	
		Loadings	Indicator Reliability	AVE	Composite Reliability	Cronbach's Alpha
		>0.70	>0.50	>0.50	0.60-0.90	0.60-0.90
PE	PE1	0.890	0.792	0.837	0.954	0.936
	PE2	0.927	0.859			
	PE3	0.910	0.828			
	PE4	0.932	0.869			
EE	EE2	0.609	0.371	0.468	0.709	0.579
	EE3	0.452	0.204			
	EE4	0.910	0.828			
SN	SN1	0.842	0.709	0.685	0.897	0.847
	SN2	0.866	0.750			
	SN3	0.823	0.677			
	SN4	0.778	0.605			
FC	FC1	-0.727	0.529	0.427	0.263	0.324
	FC2	-0.471	0.222			
	FC3	0.823	0.677			
	FC4	-0.530	0.281			
BI	BI1	0.870	0.757	0.631	0.835	0.710
	BI2	0.662	0.438			
	BI3	0.836	0.699			

APPENDIX J - Indicator Exclusions in EE (continued…)

With EE1 and EE2 removed

Latent Variable	Indicators	Convergent Validity			Internal Consistency Reliability	
		Loadings	Indicator Reliability	AVE	Composite Reliability	Cronbach's Alpha
		>0.70	>0.50	>0.50	0.60-0.90	0.60-0.90
PE	PE1	0.890	0.792	0.837	0.954	0.936
	PE2	0.927	0.859			
	PE3	0.910	0.828			
	PE4	0.932	0.869			
EE	EE3	0.328	0.108	0.535	0.648	0.246
	EE4	0.981	0.962			
SN	SN1	0.843	0.711	0.685	0.897	0.847
	SN2	0.866	0.750			
	SN3	0.822	0.676			
	SN4	0.778	0.605			
FC	FC1	-0.727	0.529	0.427	0.264	0.324
	FC2	-0.473	0.224			
	FC3	0.822	0.676			
	FC4	-0.529	0.280			
BI	BI1	0.868	0.753	0.629	0.835	0.710
	BI2	0.649	0.421			
	BI3	0.844	0.712			

APPENDIX J - Indicator Exclusions in EE (continued…)

With EE1 and EE3 removed

Latent Variable	Indicators	Convergent Validity			Internal Consistency Reliability	
		Loadings	Indicator Reliability	AVE	Composite Reliability	Cronbach's Alpha
		>0.70	>0.50	>0.50	0.60-0.90	0.60-0.90
PE	PE1	0.890	0.792	0.837	0.954	0.936
	PE2	0.927	0.859			
	PE3	0.910	0.828			
	PE4	0.932	0.869			
EE	EE2	0.550	0.303	0.600	0.737	0.405
	EE4	0.947	0.897			
SN	SN1	0.842	0.709	0.685	0.897	0.847
	SN2	0.866	0.750			
	SN3	0.822	0.676			
	SN4	0.778	0.605			
FC	FC1	-0.727	0.529	0.427	0.264	0.324
	FC2	-0.472	0.223			
	FC3	0.823	0.677			
	FC4	-0.529	0.280			
BI	BI1	0.870	0.757	0.630	0.835	0.710
	BI2	0.657	0.432			
	BI3	0.838	0.702			

APPENDIX J - Indicator Exclusions in EE (continued…)

With EE1, EE2, and EE3 removed

Latent Variable	Indicators	Convergent Validity			Internal Consistency Reliability	
		Loadings	Indicator Reliability	AVE	Composite Reliability	Cronbach's Alpha
		>0.70	>0.50	>0.50	0.60-0.90	0.60-0.90
PE	PE1	0.890	0.792	0.837	0.954	0.936
	PE2	0.927	0.859			
	PE3	0.910	0.828			
	PE4	0.932	0.869			
EE	EE4	1.000	1.000	1.000	1.000	1.000
SN	SN1	0.843	0.711	0.685	0.897	0.847
	SN2	0.866	0.750			
	SN3	0.822	0.676			
	SN4	0.778	0.605			
FC	FC1	-0.727	0.529	0.427	0.265	0.324
	FC2	-0.474	0.225			
	FC3	0.822	0.676			
	FC4	-0.529	0.280			
BI	BI1	0.868	0.753	0.629	0.833	0.710
	BI2	0.6544	0.428			
	BI3	0.847	0.717			

APPENDIX K - Indicator Exclusions in FC

With FC2 removed

Latent Variable	Indicators	Convergent Validity			Internal Consistency Reliability	
		Loadings	Indicator Reliability	AVE	Composite Reliability	Cronbach's Alpha
		>0.70	>0.50	>0.50	0.60-0.90	0.60-0.90
PE	PE1	0.890		0.837	0.954	0.936
	PE2	0.927				
	PE3	0.910				
	PE4	0.932				
EE	EE2	0.609		0.468	0.709	0.579
	EE3	0.453				
	EE4	0.909				
SN	SN1	0.842		0.685	0.897	0.847
	SN2	0.866				
	SN3	0.823				
	SN4	0.778				
FC	FC1	-0.684		0.506	0.068	0.045
	FC3	0.880				
	FC4	-0.525				
BI	BI1	0.870		0.631	0.835	0.710
	BI2	0.663				
	BI3	0.835				

APPENDIX K - Indicator Exclusions in FC (continued…)

With FC4 removed

Latent Variable	Indicators	Convergent Validity			Internal Consistency Reliability	
		Loadings	Indicator Reliability	AVE	Composite Reliability	Cronbach's Alpha
		>0.70	>0.50	>0.50	0.60-0.90	0.60-0.90
PE	PE1	0.890		0.837	0.954	0.936
	PE2	0.927				
	PE3	0.910				
	PE4	0.932				
EE	EE2	0.609		0.468	0.709	0.579
	EE3	0.452				
	EE4	0.910				
SN	SN1	0.842		0.685	0.897	0.847
	SN2	0.866				
	SN3	0.823				
	SN4	0.778				
FC	FC1	-0.672		0.483	0.040	0.023
	FC2	-0.467				
	FC3	0.883				
BI	BI1	0.870		0.631	0.835	0.710
	BI2	0.662				
	BI3	0.836				

APPENDIX K - Indicator Exclusions in FC (continued…)

With FC2 and FC4 removed

Latent Variable	Indicators	Convergent Validity			Internal Consistency Reliability	
		Loadings	Indicator Reliability	AVE	Composite Reliability	Cronbach's Alpha
		>0.70	>0.50	>0.50	0.60-0.90	0.60-0.90
PE	PE1	0.890		0.837	0.954	0.936
	PE2	0.927				
	PE3	0.910				
	PE4	0.932				
EE	EE2	0.609		0.468	0.709	0.579
	EE3	0.453				
	EE4	0.909				
SN	SN1	0.842		0.685	0.897	0.847
	SN2	0.866				
	SN3	0.823				
	SN4	0.778				
FC	FC1	-0.611		0.427	0.139	-1.023
	FC3	0.952				
BI	BI1	0.870		0.631	0.835	0.710
	BI2	0.662				
	BI3	0.836				

APPENDIX L - Results of the Investigation of a Revised Model

Reflective Measurement Revised Model Assessment

Latent Variable	Indicators	Convergent Validity			Internal Consistency Reliability	
		Loadings	Indicator Reliability	AVE	Composite Reliability	Cronbach's Alpha
		>0.70	>0.50	>0.50	0.60-0.90	0.60-0.90
PE	PE1	0.893	0.797	0.837	0.954	0.936
	PE2	0.929	0.0.864			
	PE3	0.907	0.823			
	PE4	0.930	0.865			
EE	EE2	0.540	0.292	0.444	0.677	0.579
	EE3	0.386	0.149			
	EE4	0.945	0.892			
SN	SN1	0.851	0.724	0.684	0.896	0.0.847
	SN2	0.872	0.761			
	SN3	0.815	0.664			
	SN4	0.768	0.589			
BI	BI1	0.870	0.757	0.776	0.874	0.711
	BI3	0.891	0.795			

Reflective Measurement Revised Model Assessment

Latent Variable	Indicators	Convergent Validity			Internal Consistency Reliability	
		Loadings	Indicator Reliability	AVE	Composite Reliability	Cronbach's Alpha
		>0.70	>0.50	>0.50	0.60-0.90	0.60-0.90
PE	PE1	0.893		0.837	0.954	0.936
	PE2	0.929				
	PE3	0.907				
	PE4	0.930				
EE	EE2	0.490		0.588	0.721	0.405
	EE4	0.967				
SN	SN1	0.851		0.684	0.896	0.847
	SN2	0.872				
	SN3	0.815				
	SN4	0.768				
BI	BI1	0.869		0.776	0.874	0.711
	BI3	0.893				

Reflective Measurement Revised Model Assessment

Latent Variable	Indicators	Convergent Validity			Internal Consistency Reliability	
		Loadings	Indicator Reliability	AVE	Composite Reliability	Cronbach's Alpha
		>0.70	>0.50	>0.50	0.60-0.90	0.60-0.90
PE	PE1	0.893		0.837	0.954	0.936
	PE2	0.930				
	PE3	0.907				

	PE4	0.930				
EE	EE3	0.278		0.529	0.630	0.246
	EE4	0.990				
SN	SN1	0.850		0.684	0.896	0.847
	SN2	0.872				
	SN3	0.815				
	SN4	0.768				
BI	BI1	0.864		0.775	0.873	0.711
	BI3	0.897				

Reflective Measurement Revised Model Assessment

Latent Variable	Indicators	Convergent Validity			Internal Consistency Reliability	
		Loadings	Indicator Reliability	AVE	Composite Reliability	Cronbach's Alpha
		>0.70	>0.50	>0.50	0.60-0.90	0.60-0.90
PE	PE1	0.893		0.837	0.954	0.936
	PE2	0.930				
	PE3	0.907				
	PE4	0.930				
EE	EE4	1.000		1.000	1.000	1.000
SN	SN1	0.850		0.684	0.896	0.847
	SN2	0.872				
	SN3	0.815				
	SN4	0.768				
BI	BI1	0.862		0.775	0.873	0.711
	BI3	0.898				

Scenarios around EE

Exclusions	Convergent Validity	Internal Consistency Reliability	
	AVE	Composite Reliability	Cronbach's Alpha
	>0.50	0.60-0.90	0.60-0.90
None	0.444	0.677	0.579
EE2	0.588	0.721	0.405
EE3	0.529	0.630	0.246
EE2, EE3	1.000	1.000	1.000

Path Coefficients and Total Effects

Latent Variable	BI	USE
PE	0.223	-0.038
SN	0.253	-0.044
EE	0.476	-0.082
BI		-0.172

Outer Model t Statistics and p Values

Relationship	*t* Statistic	*p* Value	Significant at 5% level?	Confidence Interval Bias Corrected	
				2.5%	97.5%
PE → BI	1.910	0.062	No	0.160	0.702
EE → BI	4.074	0.000	Yes	0.407	0.723
SN → BI	3.452	0.001	Yes	0.101	0.366
BI → USE	1.561	0.125	No	-0.416	0.017