DETERMINING THE EFFECTIVENESS OF WEB-BASED DISTANCE EDUCATION OF MITIGATING THE RURAL-URBAN ACHIEVEMENT GAP

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Determining the Effectiveness of Web-based Distance Education in Mitigating the Rural-Urban Achievement Gap

by
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ABSTRACT

This study was designed to understand how the delivery method of web-based distance courses compares to that used in classroom-based courses and to determine whether students in web-based distance courses perform on par with those in classroom-based courses, if given the same contexts. Until this is more fully understood, any differences in achievement levels between web-based distance courses and classroom-based courses will be poorly understood, leaving the potential that future decision-making will be based on simplistic notions related to any existing differences. It is the intent of this study to compare student achievement between web-based distance and classroom-based courses with particular focus on determining the effectiveness of web-based distance education in lessening the rural-urban achievement gap.

The data for this study came from the Department of Education, Newfoundland and Labrador and the Center for Distance Learning and Innovation, Newfoundland and Labrador. I studied two cohorts of high school chemistry and physics students who completed Level II and Level III science courses between September 2002 and June 2005. These students were categorized into four groups based on locality (rural or urban) and course delivery method (classroom-based or web-based). The categories were as follows: (1) urban students who enrolled only in classroom-based chemistry and physics courses, (2) rural students who enrolled only in classroom-based chemistry and physics courses, (3) rural students who enrolled in Level II

classroom-based chemistry and physics courses and Level III web-based chemistry and physics courses, and (4) rural students who enrolled only in web-based chemistry and physics courses. A repeated measures general linear model was used to predict students' achievement in the Level II and Level III chemistry and physics courses in each of the above noted categories.

The main finding from this analysis was that there were no achievement differences between urban students who enrolled only in classroom-based chemistry and physics courses, and rural students who enrolled only in web-based chemistry and physics courses. However, there was an achievement difference between urban and rural students who enrolled in Level III classroom-based chemistry and physics courses. Consequently, I conclude that web-based distance education chemistry and physics courses delivered through CDLI are not only as effective as the physics and chemistry courses offered in the traditional classroom-based environment, but they have the potential to overcome the achievement gap between rural and urban students that has traditionally favored the urban students.

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CHAPTER 1: INTRODUCTION

In this study, I am investigating differences in the effectiveness of web-based distance education science courses and classroom-based science courses within the Newfoundland and Labrador K-12 school system. To investigate these differences, I compared the mean academic achievement of students in each group. In order to have a comprehensive interpretation of the means, I reviewed the factors that could influence students' academic achievement within the context of this study. Generally, students enrolled in high school web-based distance education courses in Newfoundland and Labrador are from rural communities (Barbour, 2007; Hannum, Irvin, Lei, & Farmer, 2008; Hobbs, 2004). As well, there seems to be a consensus in the literature that rural students are academically disadvantaged in comparison to their urban counterparts (Barbour, 2007; Fan & Chen, 1999; Hobbs, 2004; Lee & McIntire, 2000, 1999; Reeves & Bylund, 2005; Reeves, 2003; Roscigno & Crowley, 2001; Webster & Fisher, 2000; Young, 1997, 1998a, 1998b). Because the students in web-based distance education courses are from rural communities, they may experience the same academic disadvantages as other rural students. Therefore, in order to compare the effectiveness of web-based distance education science courses and classroom-based science courses within Newfoundland and Labrador, it is essential to be aware of the well-documented achievement gap between rural and urban students.

Dewey (2004) argues that schools have to create a "community life in which all those agencies are concentrated that will be most effective in bringing the child to share in the inherited resources of the race, and to use his own powers for social ends" (p. 19). Teachers, according to Dewey, are members of the community that select the student influences. These influences are decided in contexts of the school community. Therefore, the context of the community in which web-based distance courses and classroom-based courses are offered must be understood if educators are to promote a quality education for all students. It appears that Dewey's concept of the "social institute" is similar to the educational movement of developing professional learning communities. According to Dufour (2004):

> When a school begins to function as a professional learning community …teachers become aware of the incongruity between their commitment to ensure learning for all students and their lack of a coordinated strategy to respond when some students do not learn. The staff addresses this discrepancy by designing strategies to ensure that struggling students receive additional time and support, no matter who their teacher is. (p.8)

In summary, I have argued that it is essential to be aware of the rural-urban contexts of the students enrolled in each of the different course delivery methods (i.e. web-based distance courses and classroom-based courses) in order to have a comprehensive understanding of any achievement differences. While there is growing evidence that there is no significant difference in student achievement between web-based distance and classroom-based courses (Cavanaugh, Gillan, Kromrey, Hess & Blomeyer, 2004; Seifert, Sheppard & Vaughan, 2008; Ungerleider & Burns, 2003; Voogt & Knezek, 2008), Crocker (2007) raised four questions related to the effectiveness of the delivery of web-based distance education courses for high school students in rural Newfoundland and Labrador. He asked as follows:

1) Are the observed differences primarily a function of instructional practices or

are they external to the mode of instruction? (p. 74)

2) Are there ways to improve aspects of distance education instruction that would remove the observed differences? (p.75)

3) Can [distance education strategies] be developed that would actually yield improved achievement compared to what some would argue are relatively mediocre results for conventional instructional strategies? (p.75)

4) [Are] differences between modes of instruction … as great as those within modes and whether … Internet-based instruction offers the possibility of reducing variations and bringing the highest quality instruction to all? (p.75)

As well, it appears that many parents initially have serious concerns with web-based distance education courses. For instance, Barry (2009), a senior administrator with the Center for Distance Learning and Innovation (CDLI) in Newfoundland and Labrador observed the following:

> Because Internet based distance education differs so much from the experience of the typical parent, most are initially skeptical when the possibility of a distance education solution is brought forward. The typical parent response is one of curiosity and a little caution. This is something CDLI is well aware of. Throughout its history it therefore has taken steps to ensure that all stakeholders are aware of the major aspects of its distance education program prior to it delivering service to any given school. This step is generally deemed crucial by all CDLI administration. It has been CDLI's experience, though, that once students, parents and school staff are made fully aware of the procedures and potential benefits they are generally positive and willing to give it a try.
> (personal communication, M. Barry; July 2009).

Given the continued existence of such uncertainty related to the delivery of web-based distance courses, it is prudent to determine whether there is an achievement gap between web-based distance and classroom-based courses. As well, within the aforementioned context, if there is an achievement gap found between web-based distance and classroom-based courses, it is imperative to know the extent to which such a gap might be explained by differences in urban and rural contexts. As discussed by Dewey (2004), students learn in relation to their background contexts. The contexts for web-based distance and classroom-based courses are different since both are offered in different localities. Therefore, when discussing achievement differences between web-based distance and classroom-based courses, the characteristics of differing localities must be considered.

Much research has been conducted to compare the academic effectiveness of rural schools to urban schools (see Barbour, 2007; Fan & Chen, 1999; Hobbs, 2004; Lee & McIntire, 2000, 1999; Reeves & Bylund, 2005; Reeves, 2003; Roscigno & Crowley, 2001; Webster & Fisher, 2000; Young, 1997, 1998a, 1998b). The confluence of evidence of the above noted research that I have outlined in some detail in my review of literature (Chapter 2) acknowledges that students in rural schools, and especially those in rural remote schools, have to overcome a number of disadvantages in order to be as effective as their urban counterpart. These disadvantages are as follows:

1) Lower socioeconomic status
   (Archibald, 2006; Ascher & Fruchter, 2001; Chiu & Khoo, 2005; Cooper, 1999; Hoy, Tarter, & Hoy, 2006; Krashen, 2005; Konstantopoulos, 2006; Raudenbush, Fotiu & Cheong,1998, 1999; Roscigno, & Ainsworth-Darnell, 1999)

2) Fewer resources
   (Archibald, 2006; Chiu & Khoo, 2005; Greenwald, Hedges, & Laine, 1996; Raudenbush, Fotiu & Cheong, 1998; Roscigno, & Ainsworth-Darnell, 1999)

3) Lower levels of intrinsic motivation
   (Benner & Mistry, 2007; Cooper, 1999; Greene, Miller, Crowson, Duke, & Akey, 2004; House, 2004; Webster, & Fisher, 2000; Hoy, Tarter, & Hoy, 2006; Young, 1997, 1998a, 1998 B)

4) Fewer qualified teachers
   (Archibald, 2006; Ascher & Fruchter, 2001; Chiu & Khoo, 2005; Copper, 2000; Dibbon and Sheppard, 2001, Fetler, 1999, Greenwald, Hedges, & Laine, 1996;

Hobbs, 2004; Raudenbush, Fotiu & Cheong,1998, 1999; Riggs, 1987; Schacter, & Thum, 2004; Shen, Mansberger, & Yang, 2004)

5) Fewer advanced course offerings
(Barbour, 2007; Brown, Sheppard, & Stevens, 2000; Crocker & Riggs, 1979; Hobbs, 2004)

In adopting the language brought forward by Seifert, Sheppard, and Vaughan (2009) in the discussion pertaining to the comparison of distance education to on-campus classroom learning, I will refer to the aforementioned disadvantages as disadvantaging experiences. In response to a recognition of these disadvantaging experiences and in an effort to provide students in rural and remote schools with equitable learning opportunities so that they could be as successful as their urban counterparts, a growing number of state and provincial authorities, including the Department of Education of Newfoundland and Labrador, have implemented distance education programs (Barbour, 2007; Beldarrain, 2006; Brown, Sheppard, & Stevens, 2000; Cavanaugh et al., 2004; Hobbs, 2004).

Distance education has the potential to reduce the rural disadvantages because it involves teaching and learning that is not restricted by time or space as in traditional classroom-based courses (Barbour, 2007; Beldarrain, 2006; Hobbs, 2004, Cavanaugh et al., 2004; Hannum, Irvin, Lei, & Farmer, 2008). Furthermore, with the advancements in computer and communication technologies, distance education–more appropriately defined as web-based distance education (Barbour, 2007; Beldarrain, 2006; Cavanaugh et al., 2004)–has largely eliminated the aforementioned disadvantages. In Chapter 2, I have established through my review of literature that there are background contexts that limit rural students' academic success. Consequently, if web-based distance education science courses enable rural students to experience academic success at levels comparable to their urban counterpart, it can be concluded that web-based distance education is an effective means of reducing the rural disadvantages.

Web-based distance education within Newfoundland and Labrador has expanded exponentially over the last two decades. According to Boone (2008), it was not formally recognized within the Newfoundland and Labrador School System that there was a need to offer distance education in rural communities until the release of the Report of the Small School Study Project (Riggs, 1987) that highlighted the need for a distance education program in rural senior high schools through the following recommendations:

> That by direct classroom teaching or by distance education, all senior high schools should have the ability to offer all courses which are prerequisite to entry into post-secondary institutions and the ability to accommodate particular course requirements of small numbers of students.
>
> That measures be taken to ensure that a course in high school chemistry level 2 and a course in high school physics level 2 are available to small high schools by September 1987. Consideration should be given to delivery by computers, audio-video tapes or by other means of distance education.
>
> That greater use of technology be made in program delivery in small schools; especially in small high schools.
>
> That a Distance Education School be established and a principal and teachers be employed to assume responsibility for the development and administration of distance education courses. (Riggs, 1987)

Following these recommendations, the Department of Education, Newfoundland and Labrador, searched for a distance education model that marked the beginning of distance education in Newfoundland and Labrador. Boone (2008) explains that, as a consequence, the Telemedicine and Educational Technology Resources Agency (TETRA) model was expanded to deliver high school courses to rural communities of Newfoundland and Labrador. Because the TETRA model was an analog network that relied on audio-graphics technology, synchronous teaching and learning was required. In addition to the TETRA model of delivery, "facsimile machines were provided to each of the small rural schools as an integral component of the distance learning model for the transmission of completed student assessment instruments" (Boone, 2008, p.22). Confirming Boone's account of the commencement of distance education, Brown, Sheppard, and Stevens (2001) state that distance education was initially implemented to address the inability of "small rural schools …to offer the Advanced Mathematics Program [Advanced Mathematics 1201, 2201 and 3201]". To that effect, in the 1988-89 school year, the first distance course that was offered through the TETRA technology was Advanced Mathematics 1201. A total of 36 students in 13 rural schools throughout Newfoundland and Labrador were enrolled in this first course (Boone, 2008; Sparkes & Williams, 2000).

Distance education has been a growing method of delivery within the K-12 system in Newfoundland and Labrador since it was first implemented in September, 1988. Brown et al. report that by the 1999-2000 school year,

> Senior high school students in small rural schools have had the opportunity to study 11 senior high school courses in Advanced Mathematics, Physics, Chemistry and French. There were 77 schools participating with 898 course enrolments [703 students] and 27 Web-based distance Education Instructors [full-

time or part-time] that have been allocated by school district offices. (p. 2)

However, it was not until the distance education model moved from an analog system to a web-based system that the face of rural education really began to change. Brown et al. (2001) argue that the shift toward web-based distance education has had a substantial effect on the teaching and learning process that, in turn, has facilitated considerable expansion of course offerings throughout the Province. This change to web-based course delivery was predominately influenced by the Sparks and Williams (2000) Report. In this report, the authors concluded that "the province may have reached the point at which further consolidation in rural areas will be difficult because of the distances and the continuing relative isolation of some communities" (p. 9). They projected a continued decline in student population in Newfoundland and Labrador and therefore, recommended that in order to provide equal educational opportunity to high school students throughout Newfoundland and Labrador "the province [should] embark on a program to substantially increase the scope of distance education offerings in the schools through the establishment of a "Centre for Distance Learning and Innovation" (Sparkes & Williams, 2000, p. 73). Government implemented this recommendation in December, 2000 (CDLI, 2009). Since the creation of CDLI, web-based distance education courses have been offered in over forty high school courses throughout Newfoundland and Labrador.

With such expansion of web-based distance education and an increasing spread of courses, it is important to ascertain whether web-based distance education courses are as effective as those of the traditional classroom-based courses. This is not a simple question. There are a number of factors that may affect the academic achievement of web-based distance education courses. For instance, students who enroll in web-based distance education courses are primarily from rural or rural remote schools (Barbour, 2007; Hobbs, 2004) and therefore, as previously noted above have differing background experiences that have been found to impact achievement outcomes. Furthermore, it has been well documented that completion of web-based distance education courses requires students to work with a higher level of autonomy and responsibility (Barbour & Reeves, 2009; Cavanaugh et al., 2004). If students who are enrolled in web-based distance courses cannot meet these higher expectations, they may experience difficulty in their courses and, consequently, academic achievement may be lower.

All the differences between the students who generally enroll in web-based distance courses and those who enroll in classroom-based courses cannot be controlled experimentally. In response to the aforementioned challenge, Seifert et al. (2009) argue that testing the achievement level of students in distance education and comparing the results to those of students in classroom-based courses is actually testing how the differing experiences affect achievement. That is, if students have the same experiences then they would probably achieve at the same level. They explain that,

> [there are] a number of issues concerning validity [that] can be raised when trying to compare distance education (DE) to on-campus classroom learning (CL) formats. One obvious concern is whether or not a DE course is the same as its on-campus counterpart. Given the nature of DE, it seems reasonable to say that it is not the same course because of differences in interactions, opportunities for feedback, and access to resources, for example. While we acknowledge the differences, the question before us is not necessarily a casual question to be answered in an experimental or quasi-experimental design. That is, any differences in students' grades that might exist between DE and CL classes may not necessarily be attributed to delivery format alone. For example, there may be

> important differences in characteristics of students choosing DE rather than CL...which may result in variations in students' motivation and performance. This leads to the conclusion that DE is a type of learning experience, and it is that learning experience that is being examined. (p. 144)

Purpose

The purpose of this study was to determine if web-based distance education science courses are at least as effective as traditional science classroom environments within Newfoundland and Labrador. The complexity of this investigation is not fully appreciated until all factors that have the potential to affect student achievement are considered. When asking the following question, "Is distance education science courses as effective as traditional classroom-based science courses?" a single test of mean achievement differences is not sufficient. The above test would not suffice because students with differing backgrounds may have differing degrees of success; furthermore, the degree of a student's success may change with experience. To exert some control over student background, I used preliminary analysis in order to determine groupings in respect to science course offerings, locality, and delivery method. The analysis revealed that within the science courses, only physics and chemistry were available through CDLI. Within these two subject areas, there were two possible courses available to students at the high school-level. The physics courses were Physics 2204, which is a Level II course, and Physics 3204, a Level III course. The chemistry courses were Chemistry 2202, which is a Level II course, and Chemistry 3202, a Level III course. As well, I discovered that chemistry and physics students in urban schools did not enroll in courses offered through CDLI. In regards to rural students, there were three distinct categories for both chemistry and physics students. There were rural students that were taught in a classroom-based environment for both grade levels. There were rural students who completed the Level II science course in the classroom; however, they enrolled in the third level science course through CDLI. Finally, there were rural students that completed both grade levels through CDLI. Therefore, within each subject area, students were classified into the following four groups:

UST_L2C_L3C Group	Urban students (UST) enrolled only in classroom-based courses(C) [Level 2 (L2), Level 3(L3)]
RST_L2C_L3C Group	Rural students (RST) enrolled only in classroom-based courses (C) [Level 2 (L2), Level 3(L3)]
RST_L2C_L3D Group	Rural students (RST) enrolled in one classroom-based course(C), a Level II science (L2), and one web-based course (D), a Level III science (L3)
RST_L2D_L3D Group	Rural students (RST) enrolled only in web-based courses (D) [Level 2 (L2), Level 3(L3)]

As a result, the central question of this thesis–whether the distance education courses are as effective as traditional classroom-based courses–has evolved into the following four research questions based on each of the groups above:

1) Are there differences in student achievement in the Level II science courses between the UST_L2C_L3C Group and the other groups?

2) Are there differences in student achievement in the Level III science courses between the UST_L2C_L3C Group and the other groups?

3) Are there differences in student achievement between the Level II and Level III science courses within the groups?

4) If question three reveals differences, are these differences attributed solely to the different course levels or do the differences vary for the groups?

These groupings allowed me to indirectly control for differing student background characteristics that might exist as a consequence of their urban or rural contexts. My review of literature related to web-based distance education has revealed that students enrolled in web-based distance education courses are primarily from rural regions. As well, I have identified a rural-urban achievement gap that, as previously noted, appears to result from a number of disadvantaging experiences that appear to be inherent to the rural context. That is, if these disadvantaging experiences were eliminated, rural students should perform as well as urban students. The first group (*urban students enrolled only in classroom-based courses)* is the control group. When comparing the control group to the RST_L2C_L3C Group (*rural students enrolled only in classroom-based courses)*, I expected my analysis to reveal differences because the disadvantaging experiences would cause rural students to have lower achievement levels than urban students. However, I did not expect to find differences between the control group and the RST_L2D_L3D Group (*rural students enrolled only in web-based courses*) because web-based distance education courses provide rural students with the opportunity to lessen the negative effects associated with the disadvantaging experiences, and therefore there is no actual rural-urban achievement gap. Essentially, comparing achievement levels of students in the control group to the RST_L2D_L3D Group allowed me to control for the disadvantaging experiences through the use of web-based distance education. Finally, the RST_L2C_L3D Group (*rural students enrolled in one classroom-based course, a Level II science, and one web-based course, a Level III science*) allowed me to determine how important student autonomy and responsibility is to achievement in web-based distance education courses. These distance education students had enrolled in only one

Level III physics or chemistry course through CDLI. Therefore, these students may not have yet adapted to the higher level of autonomy and responsibility that is required for the successful completion of either Level III physics or chemistry through CDLI. By comparing this group of rural students to the other groups, I was able to assess the importance of these two student characteristics (autonomy and responsibility) to the level of success students will experience in a web-based distance course.

Relevancy

This study is valuable from a number of vantage points. Web-based distance education is a relatively new model of teaching and learning. In fact, in Newfoundland and Labrador, CDLI was founded as recently as December, 2000 (CDLI, 2009). Given the evidence in respect to the disadvantaging experiences of rural students that contribute to their achieving below their urban counterparts, any comparison of rural students enrolled in web-based distance courses with those in regular classroom-based courses must be interpreted from this perspective.

CDLI was implemented to provide comparable learning opportunities to rural and urban students. However, if the disadvantaging experiences that have been associated with rural students' lower achievement levels have not been accounted for by CDLI, the possibility for web-based distance education courses to overcome these achievement barriers will be impeded. Therefore, this study was conducted to help elucidate these disadvantaging experiences and to determine if CDLI has been successful in overcoming them. As well, findings of this study should specifically contribute to the overall concreteness of research in web-based distance education and rural education.

Ethical Considerations

Commencement of this study involved the acceptance of the ethics proposal submitted by members of the Killick Centre Effective Study (see Appendix A). As a graduate student working with the Killick Centre Effectiveness Study research team my research has been approved by the Interdisciplinary Committee on Ethics in Human Research at Memorial University. The ethical considerations relate primarily to the protection of privacy (See Appendix B) and the Killick Centre researchers committed to three measures to ensure that the protection of privacy is guaranteed. First, all identifying information, such as MCP numbers were removed and replaced with proxy numbers. Second, the original data files, with identifying information, were available only to senior Killick Centre researchers. Consequently, the dataset with which I worked had been cleansed of all identifying student personal information. Finally, the third condition imposed to protect privacy was that no identifying information of students or schools would be shared with others outside of the research team and would not be contained in public reports such as this thesis. I committed to adhere to the applicable conditions noted above by signing a Commitment of Privacy and Confidentiality Document (see Appendix B).

Summary

In this chapter, I have provided an overview of my research thesis topic and a synopsis of the related literature in order to provide a framework for my research and to establish the need for it. As well, I have identified the purpose of my study, its relevance, and ethical considerations. The following chapter of this thesis provides a review of the literature related to distance education and rural-urban differences in student achievement. In Chapters 3 and 4, I describe my methodology and results, respectively. In Chapter 5, I discuss the implications of the results. Finally, in Chapter 6, I discuss the limitations of this study and make recommendations for future research and practice.

CHAPTER 2: REVIEW OF LITERATURE

Web-based Distance Education

Condition of Web-based Distance Education Research

The field of research surrounding distance education, specifically web-based distance education in K-12 system, is small (Cavanaugh,1999; Cavanaugh, Gillan, Kromrey, Hess, & Blomeyer, 2004; Hannum, Irvin, Lei, & Farmer, 2008; Rice, 2006; Ryan, 1996). In fact, Cavanaugh (1999) found only nineteen articles suitable for her meta-analyses; and she argues that this fact supports the argument that the research in web-based distance education in the K-12 context is limited. In addition, a number of authors argue that comparative studies of distance education to traditional classroom instruction are not always conclusive (Bernard, Abrami, Lou, Borokhovsk, Wade, Wozney, Wallet, Fiset, & Huang, 2004; Cavanaugh, Gillan, Kromrey, Hess, & Blomeyer, 2004; Rice, 2006; Tallent-Runnels, Thomas, Lan, Cooper, Ahern, Shaw and Liu, 2006). For example, Bernard et al (2004) argue that much distance education research is of low quality. They contend that much of the research has not placed adequate "controls for confounds and inequalities" (p. 416). Similarly, Tallent-Runnels et al. (2006) observe that a large quantity of the distance education research is poorly designed and methodologically weak. Another concern with distance education research is the lack of a specific operational name for the various delivery methods within distance education. Tallent-Runnels et al. argue that there are many different terms for distance education that are inconsistently used for differing delivery methods. Therefore, they recommend that each delivery method in distance education courses should be operationally defined.

For example, they have suggested that, "courses taught totally online should be called *online courses*. Those with an online component added might be called *hybrid or blended courses*" (p.115). In this study, the term web-based distance course is a course taught entirely online while a classroom-based course is a course taught in the traditional classroom whereby any use of the internet is at the discretion of the teacher.

Effectiveness of Distance Education

The effectiveness of distance education is determined typically by comparing the academic achievement of students enrolled in distance education courses to those enrolled in traditional classroom-based courses. If the average academic achievement of students enrolled in web-based distance education courses is at least equal to that of classroom-based students, it can be concluded that distance education courses are effective. However, as described in the previous section, distance education research, in general, has not been able to provide a definitive answer in respect to the effectiveness of distance education. It has been argued that studies that involve meta-analysis can provide a more reliable conclusion (Bernard, Abrami, Lou, Borokhovsk, Wade, Wozney, Wallet, Fiset, & Huang, 2004; Shachar, 2008). Overall, results of a number of meta-analysis comparing distance education and classroom-based courses have generated a consistent conclusion that academic achievement of students enrolled in distance education courses in both K-12 and post secondary environments is comparable to the academic achievement of those enrolled in classroom-based courses (Bernard et al., 2004; Cavanaugh, 1999; Cavanaugh, Gillan, Kromrey, Hess, & Blomeyer, 2004; Zhao, Lei, Yan, Lai, & Tan, 2005). However, much of the research presents a large variance.

Bernard et al (2004) contend that while the results of their meta-analysis reveal that the achievement levels of students in both distance education courses and classroom-based courses are on average the same, there is great variability. They explain that,

> while the average effect of DE was near zero, there was a tremendous range of effect sizes (g) in achievement outcomes, from -1.31 to +1.41. There were instances in which the DE group outperformed the traditional instruction group by more than 50%, and there were instances in which the opposite occurred, for example, the traditional instructional group outperforming the DE group by 48% or more. (P.406)

Similarly, Cavanaugh et al (2004) revealed that while there is much variability among the differing studies, on average there is no difference between the academic achievement of K-12 students enrolled in distance education and those enrolled in classroom based courses. They conclude that, "students can experience similar levels of academic success while learning using telecommunications and learning in classroom setting". (p.21) Cavanaugh arrived at the same conclusion in her 1999 meta-analysis and commented that,

> Distance education can be expected to result in achievement at least comparable to traditional instruction in most academic circumstances. Educators planning implementations of distance education programs should expect no difference in academic performance as a result of the use of distance education.
> (Cavanaugh, 1999, p18)

Similarly, Zhao et al. (2005), having tested the homogeneity of the differing effect sizes in their meta-analysis, revealed that overall there is no difference between the achievement level of web-based distance education and classroom-based education. They noted, however, that differences exist on an individual basis. They concluded that,

> Studies suggest that there is no significant difference between distance education and face-to-face education, confirming the ''no significant difference'' claim of previous researchers. However, a closer look at the data revealed considerable variation among the effect sizes: There is a wide range of effect sizes (from -1.43 to 1.48); about two thirds of the studies show that distance education produced better student outcomes than face-to-face education, whereas the remaining third showed just the opposite. (p.1854)

Intrigued by the reported results of the above noted meta-analyses, Seifert, Sheppard, and Vaughan (2008) conducted an investigation to better understand the nature of the heterogeneity of the achievement effect sizes. Employing a data set comprised of 39,689 course registrations, 61 different instructors teaching 47 different courses at one Canadian university, they concluded that it is somewhat simplistic to interpret the finding of *no significant difference* to mean that the performance in distance education is always comparable to that in classroom-based courses. Findings of their study revealed that in reality students in distance education outperformed those in classroom-based courses in half of the studies, while students in classroom-based courses outperformed those in distance education in the other half, resulting in a net gain of zero.

Research studies into the effectiveness of distance education, other than the above meta-analyses, have arrived at the same conclusions. After having conducted a comprehensive review of 91 articles related to distance education research, Tallent-Runnels, Thomas, Lan, Cooper, Ahern, Shaw and Liu (2006) concluded that distance education methodologies are as effective as classroom-based methodologies. However, similar to the conclusion reached by Seifert et al. (2008), they observed that the results fluctuated, with some studies favoring distance education methodologies while others favored classroom-based methodologies.

Rural/Remote Schools

Condition of Rural Research

My review of literature reveals that findings related to rural-urban differences are conflicting and inconclusive (Fan & Chen, 1999; Khattri, Riley and Kane, 1997; Reeves and Bylund, 2005). Among the studies that have found achievement gaps, there were differences that fluctuated from one country to another with some findings that favored rural to others that favored urban (Williams, 2005). Fan & Chen (1999) contend that these conflicting variations in findings may be attributed to studies that do not control influencing variables. Similarly, Khattri, Riley and Kane (1997) observe that research on rural education does not enable one to decipher whether an achievement gap between rural and urban students is caused by differing localities or other confounding variables. They contend that confounding variables have not been dealt with properly. Furthermore, they argue that in the past, rural education research has been limited by inferior control variables and the absence of comparison groups. Reeves and Bylund (2005) make a similar argument that the poor quality of data relating to rural research has limited the degree of advanced analysis that is required. They observe that, "only in the last several decades has the quality of the data improved to the extent that sophisticated analysis became feasible" (p.362).

Inconsistency of Findings

Further confounding the interpretation of research findings in respect to differing localities and student achievement is the varying findings throughout differing regions of the world (Lee & McIntire; 2000; Williams, 2005). Williams (2005) conducted an investigation to determine the impact that locality had on mathematics achievement by using the Programme for International Student Assessment (PISA) 2000 data of Organization for the Economic Co-Operation and Development. These assessments tested 15 year olds in reading, math, and science, and locality was categorized by rural, medium-size, and urban. Williams (2005) observed that there were four emerging patterns in mathematics achievement that vary across countries. Williams defines the patterns and lists them from the most to least common as follows: (1) *rural disadvantage-urban advantage*, (2) *urban disadvantage*, (3) *rural disadvantage-urban disadvantage*, and (4) *rural advantage*. In the first pattern, *rural disadvantage-urban advantage*, there is a positive correlation with the size of the community and achievement. That is, the larger the community, the higher the achievement levels. In the second pattern, *urban disadvantage*, urban students' achievement is lower than the other two categories. The third pattern, *rural disadvantage-urban disadvantage*, occurs when the achievement levels increase as the categories switch from rural to urban, and then to medium-size communities. In this pattern the medium-size communities are achieving at the highest level. Finally, the fourth pattern, *rural advantage*, exists when rural students' achievement levels are higher than the other two categories. These patterns observed by Williams (2005) appear to accurately reflect the research evidence related to locality and student achievement and thereby, provide a convincing argument that differences are not necessarily determined uniquely by locality, but by other disadvantaging experiences that are found in the differing localities. Lee and McIntire (2000) found similar variations between the rural-urban achievement gaps in the United States. They observed interstate variations whereby the rural-urban achievement gap positively favored either rural or urban students.

Based on my current review of the evidence, it appears that locality as a unique variable does not have a negative or positive impact on achievement levels; however, there are disadvantaging experiences that are predominately found in rural communities that appear to affect achievement. Depending on the particular region or country, these predominantly rural disadvantaging experiences may be found in an urban rather than a rural community, thereby affecting urban achievement levels. Consequently, these disadvantaging experiences better help explain the differences in student achievement levels than does the use of locality as a unique factor. The most frequently identified disadvantaging experiences are as follows: (1) socioeconomic status, (2) minority groups, (3) schools' educational resources (4) students' attitude towards academics, and (5) teacher qualifications (Chiu & Khoo, 2005, Fan & Chen, 1999; Hoy, Tarter, & Hoy, (2006; Lee & McIntire, 2000, 1999; Reeves & Bylund, 2005; Reeves, 2003; Roscigno & Crowley, 2001; Beverley, Webster & Fisher, 2000; Young, 1997, 1998a, 1998a).

Socioeconomic Status

Socioeconomic status appears to be a robust predictor that positively affects student achievement (Archibald, 2006; Ascher & Fruchter, 2001; Battle & Pastrana, 2007; Bouchey & Harter, 2005; Chiu & Khoo, 2005; Condron & Roscigno, 2003; Cooper, 1999; Hoy, Tarter, & Hoy, 2006; Krashen, 2005; Konstantopoulos, 2006; Raudenbush, Fotiu & Cheong,1998, 1999; Roscigno, 1998; Roscigno, & Ainsworth-Darnell, 1999; Unnever, Kerckhoff, & Robinson, 2000; Wenglinsky, 2002). Many authors have claimed that there is no difference between the achievement of rural and urban students once socioeconomic status is controlled (Fan & Chen, 1999; Reeves, 2003; Reeves & Bylund, 2005; Webster & Fisher, 2000; Williams, 2005; Young, 1997, 1998a, 1998b), further illustrating that socioeconomic status negatively affects rural students' achievement levels. Roscigno and Crowley (2001) observe that rural schools have a lower socioeconomic status than urban schools and therefore, rural schools have lower achievement levels. Similarly, Lee and McIntire (1999) have revealed that rural communities generally have a lower socioeconomic status; consequently, this lowers the ability of rural students to achieve. It is apparent that socioeconomic status has a strong and positive impact on student achievement. Hence low socioeconomic status appears to have a stronger impact on achievement levels of rural students in comparison to those in urban schools because in general, rural communities are more likely to have lower socioeconomic status, particularly, in Newfoundland and Labrador (Newfoundland and Labrador, Department of Human Resources, Labour and Employment, 2005).

Minority Groups

A common theme that occurs while investigating rural and urban differences among achievement is that minority groups are generally associated with lower levels of achievement (Archibald, 2006; Ascher & Fruchter, 2001; Bouchey & Harter, 2005; Condron & Roscigno, 2003; Copper, 2000, 1999; Fan & Chen, 1999; Graham, Taylor & Hudley, 1998; Krashen, 2005, Konstantopoulos, 2006; Raudenbush, Fotiu & Cheong,1998; Reeves and Bylund, 2005; Roscigno, 1998; Roscigno, & Ainsworth-Darnell, 1999; Roscigno & Crowley, 2001; Young, 1998a, 1998b). Therefore, independent of locality, a school population composed of a larger number of minority students will more than likely have lower levels of achievement. I located only one study (Reeves, 2003) that questions such a conclusion. After having accounted for the clustering effect (minority schools being concentrated in large urban school districts), Reeves found that African-Americans did not significantly differ from majority groups in their achievement levels. Other studies, including work by Reeves and Bylund (2005), reveal that membership in an ethnic minority group does affect student achievement levels. For instance, Reeves and Bylund (2005) found that African-American minority groups perform at lower levels and exhibit a similar relationship to that which has been well documented between low socioeconomic status and achievement levels. They conclude that because there is a higher concentration of African-Americans in urban schools, these schools have lower achievement levels. Similarly, Fan and Chen (1999) and Roscigno and Crowley (2001) found that increased numbers of minority groups, such as African-Americans and Hispanics, are more likely to be found in urban schools and therefore, these schools were more likely to have lower achievement levels.

While the above results provide a convincing argument that minority groups primarily exist in urban schools and therefore, create an urban disadvantage, when the affects of aboriginal groups on achievement levels are considered, a rural disadvantage has been observed. Aboriginal groups are generally located in rural communities and have lower levels of achievement (Young, 1998a, 1998b). For instance, Young (1998a) found that,

> Aboriginal students scored poorly and…remote locations consisted of 12% and 13% Aboriginal students. Further, the Aboriginal students scored so poorly that they most likely lowered the achievement scores. That is, Aboriginal students scored .40 in Science Achievement (compared with 1.19 for non-Aboriginal

> students) and .22 in Mathematics Achievement (compared with 1.14 for non-Aboriginal students) (p. 411).

It is evident that membership in a minority group can affect achievement levels; however, it appears that rural communities are more homogeneous and therefore, have fewer minority groups. It has been argued that this leads to a rural advantage whereby rural students outperform urban students. On the other hand, rural communities are more likely to have aboriginal populations which, as noted above, have a strong negative influence on student achievement, thereby creating a rural disadvantage. Consequently, sorting out variations in achievement levels that might be explained by the impact of minority groups poses quite a challenge. This impact depends on the region and the composition of minority groups in the population. Only after an accurate description of the population is provided can it be determined whether an overall rural or urban advantage/disadvantage exists.

In Newfoundland and Labrador, the primary minority groups are the aboriginal groups that include Inuit, Innu, Metis and Mi'kmaq, the majority of whom live in rural regions (Newfoundland and Labrador, Department of Human Resources, Labour and Employment, 2005). Although neither Statistics Canada's Low Income Cut Offs or income levels are available separately for these aboriginal peoples, "various sources, particularly qualitative ones, indicate that while income levels vary greatly among aboriginal people, they are low compared with non-aboriginal levels" (Newfoundland and Labrador, Department of Human Resources, Labour and Employment, 2005, p. 8).

Schools' Educational Resources

Availably of resources is another factor which positively predicts student achievement (Archibald, 2006; Chiu & Khoo, 2005; Condron & Roscigno, 2003; Greenwald, Hedges, & Laine, 1996; Hobbs, 2004; Raudenbush, Fotiu & Cheong, 1998; Roscigno, & Ainsworth-Darnell, 1999; Unnever, Kerckhoff, & Robinson, 2000; Wenglinsky, 1998). It has been reported that at both the student-level and school-level, rural students have fewer educational resources and that these resource deficits have been found to negatively impact student achievement (Lee & McIntire, 2000; Roscigno & Crowley, 2001). After having observed differences in rural and urban achievement levels, whereby rural students were performing at lower levels, Reeves and Bylund (2005) investigated the impact of resources on achievement while controlling for the influence of differing localities. Their analysis revealed that the availability of resources independently explained differences in achievement levels, leading them to conclude that beyond the effects of location, "the resource and investment main effects…mainly contribute to the explanation of between-school variance (46 percent) rather than between district variance (3 percent)" (p.371). Reeves and Bylund's (2005) findings suggest that there are differences in the amount of available resources in rural and urban schools that favor urban schools. As well, they discovered that the quantity of resources, independent of differing localities, positively affects student achievement levels. Hence, their study provides additional support that lower levels of educational resources, which are more likely to be found in rural schools, contribute to lower achievement levels in rural schools.

Huang and Howley (1993) recognize as well, that when schools have fewer educational resources, achievement levels are negatively influenced. However, they observed that the impact of fewer resources is stronger in urban schools than rural schools. They argue that when comparing rural and urban schools with low levels of resources, the negative effect on levels of achievement will be greater in the urban schools. Similarly, Lee and McIntire (1999) observed that the different patterns of rural-urban achievement gaps can be partially explained by differences in the allocation of resources. They concluded that schools in rural or urban regions within states with higher levels of resources will more than likely have higher levels of achievement than those rural or urban regions in states with fewer resources. Therefore, their study lends further support for the view that resources positively affect achievement and that it must be considered as a mediating factor in any consideration of achievement differences between rural and urban students. However, after having surveyed teachers' perceptions of the amount of resources as measured through the School-level Environmental Questionnaire (SLEQ), contrary to the generally accepted view, Young (1997) concluded that the resource levels have no impact on student achievement:

> The teachers participating in the study completed a School-level Environmental Questionnaire (SLEQ) in order to measure their perception of this school's work environment....There were no significant effects upon student achievement noted. Further, the SLEQ variables did not explain residual variance in student achievement. (p.25)

In light of these somewhat conflicting findings among the current research evidence, one has to be careful in making a generalized statement that rural students' achievement is lower due to lower levels of educational resources. Nevertheless, on balance, the confluence of evidence is convincing that an increase in the quantity of resources positively affects student achievement. That is, schools with more resources will have higher achievement levels than schools with fewer resources, but whether or not this is a rural or urban disadvantage may be context dependent. Because the allocation of resources to schools in Newfoundland and Labrador is largely dependent upon student population levels, rural schools, most of which are small, are disadvantaged in respect to personnel and financial resources in comparison to their urban counterparts (Warren, Curtis, Sheppard, Hillier & Roberts, 2003).

Students' Attitude

Students' attitudes toward particular subjects and to school overall will influence their achievement level. Specifically, students with a positive attitude with respect to academics are more likely to have higher achievement levels (Benner & Mistry, 2007; Cooper, 1999; Greene, Miller, Crowson, Duke, & Akey, 2004; House, 2004; Hoy, Tarter, & Hoy, 2006; Singh, Granville, & Dika, 2002; Webster, & Fisher, 2000; Young, 1997, 1998a, 1998 a). Benner and Mistry (2007) observed that,

> youth's educational expectations and competency beliefs were significantly related to a majority of the academic performance indicators, even after accounting for the covariates and other relationships. (p.146)

Hoy, Tarter and Hoy (2006) performed a path analysis to determine the direct and indirect effects of factors such as socioeconomic status, academic optimism, and prior achievement on student achievement. They identified three paths revealing the influence of academic optimism on student achievement. Academic optimism mediated effects of socioeconomic status and prior achievement on student achievement, and was found to be "directly related to achievement" (p.438). Similarly to the above finding, Singh, Granville, and Dika (2002) revealed that "mathematics and science achievement among the eighth graders was influenced by motivation, attitude, and academic engagement" (p. 330). In Copper's (1999) view, the affect of a positive attitude on student achievement is so influential it can offset the negative effects of poverty and minority groups.

In respect to rural-urban differences, Beverley et al. (2000) reveal that rural students have a better attitude toward school and therefore experience an academic advantage over urban students. However, Webster et al. (2000) report that the difference in attitude between rural and urban students is small. In contrast, Young (1997, 1998a, 1998b) discovered that as a consequence of rural students having a lower academic self concept, they experience an academic disadvantage. It is evident that while there is some disagreement over how and the extent to which student attitude impacts achievement, the interpretation of any differences in student achievement found between urban and rural students must give consideration to the potential indirect effects of differing localities on achievement as a result of differing student attitudes. For instance, in a study of intermediate students in Newfoundland and Labrador, Sheppard (2008) reported that significantly more urban than rural students indicated that they aspired to obtaining a university degree. This suggests that urban students in Newfoundland and Labrador may have a more positive attitude toward higher education and the achievement of academic standards that would allow them access to university programs.

Teacher Qualifications

It appears that the general consensus is that higher teacher qualification levels positively influence student achievement (Archibald, 2006; Ascher & Fruchter, 2001;

Chiu & Khoo, 2005; Copper, 2000; Crocker & Riggs, 1979; Dibbon and Sheppard, 2001, Fetler, 1999, Greenwald, Hedges, & Laine, 1996; Hobbs, 2004; Raudenbush, Fotiu & Cheong, 1998, 1999; Schacter, & Thum, 2004; Shen, Mansberger, & Yang, 2004; Unnever, Kerckhoff, & Robinson, 2000; Wenglinsky, 2002; White &Reid; 2008). For example, Fetler (1999) revealed that mathematics scores were lowered by a shortage of qualified mathematics teachers. Of considerable concern, is that Shen, Mansberger and Yang (2004) observed that low performing schools attracted fewer qualified teachers that "further exacerbate the inequity already existing in those schools" (p.231). Others have observed that there are fewer highly qualified teachers in schools where the student population is primarily composed of ethnic minorities (Ascher & Fruchter, 2001; Copper, 2000) and they contend that less qualified teachers will exacerbate the negative effect which already exists between minority students and student achievement. For instance, Ascher and Fruchter (2001) found,

> a strong relation between teacher quality and student performance in New York City's low-performing schools and districts. The lower the percentage of teachers who were fully licensed and permanently assigned, who had significant teaching experience, who possessed advanced degrees, and who had low absentee rates, the lower the school-level student performance. (p.212)

As a result of those findings they concluded that "while student poverty and racial minority status might make school achievement more difficult…, these community-based stresses were being systematically exacerbated by stresses created by the school system" (p. 212).

While students in many rural environments might not face the severity of the social challenges of inner city ethic minorities described by Ascher and Fruchter (2001), there is some evidence that rural schools experience similar challenges in attracting qualified teachers (Dibbon & Sheppard, 2001; Lee & McIntire, 2000). More specifically, Dibbon and Sheppard (2001) identified severe shortages of qualified science teachers in rural regions of Newfoundland and Labrador. As a means of illustrating the consequence of such shortages they noted that in at least one rural school district "less than fully qualified teachers were hired with the understanding that they would upgrade their qualifications [later]" (p. 74). They further observed that, unfortunately for the rural school district, when these teachers did upgrade, it was common for them to move to larger, more urban centers thereby continuing the cycle of hiring "less than fully qualified teachers" for the rural schools. Similarly, Lee and McIntire (2000) observed that it is difficult to recruit and retain highly trained teachers in rural schools. Given the preponderance of evidence suggesting that *teacher qualifications* is a factor that influences student achievement and the challenges of recruiting and retaining qualified teachers in rural schools, teacher qualifications must be considered as a mediating factor for understanding the effects of locality on achievement. Given that the qualifications of teachers who teach distance courses in Newfoundland and Labrador are comparable to those in urban regions and those teachers are considered subject area specialists in each of the fields that they teach, it is reasonable to assume that they are on average better qualified than those in rural schools.

Course Offerings

The introduction of this report alluded to the fact that distance education was primarily implemented to combat the problem with the inability of rural, and more specifically rural/remote, schools to offer a wide range of course offerings (Barbour, 2007; Barbour & Reeves, 2004; Brown, Sheppard, & Stevens, 2000; Crocker & Riggs, 1979; Hobbs, 2004; Lee & McIntire, 1999). Crocker & Riggs (1979) observed that,

> There is little doubt that increased school size does have the effect of increasing the variety of program options available. This is because the degree of flexibility in forming class units is larger in large schools. (p.104)

In many small schools, the number of program options in high school in only one field of study such as science exceed the entire student population; consequently, in-school program options are limited by context alone. Without the provision of distance education programs, students in larger urban schools will have a larger variety of course offerings than the small rural and rural/remote schools. This contextual reality is a foundational element of this study as CDLI exists primarily for the purpose of offering courses that would otherwise not likely be available to rural students.

Newfoundland and Labrador

The following studies are reflective of the findings noted above; however, they are specifically related to Newfoundland and Labrador High Schools. Cartwright and Allen (2002) analyzed the results of the Newfoundland and Labrador students who completed the PISA 2000 survey. Their analysis revealed that urban students outperformed rural students in reading performance. The list below identifies the disadvantaging experiences that they used to explain the differences between rural and urban students:

1) Rural students were more likely to come from lower socioeconomic backgrounds. (p.13)

2) Rural students tended to come from homes with fewer cultural possessions and educational resources and they were less likely to discuss cultural, political or social issues with their parents. (p.13)

3) While most students, both rural and urban, aspire to a university education, the rate is significantly lower for rural students. (p.15)

4) Rural students in all provinces also had significantly lower career expectations than urban students. (p.15)

5) Urban school principals reported significantly higher levels of teacher specialisation than rural principals. (pp.15-16)

6) Rural areas had higher unemployment rates. (p.17)

7) Adults in rural communities had less education and fewer of them had jobs requiring a university degree. (p.17)

After having controlled for family background of each student, Cartwright and Allen (2002) found that rural students still scored at lower levels than their urban counterparts. They concluded that "differences between rural and urban communities best explain the differences in rural and urban reading performance". (p.19)

Ryan (1996) did a comparative study to determine if there were differences in average achievement of students enrolled in the web-based distance education courses and students enrolled in the classroom-based courses within the senior high advanced mathematics program in Newfoundland and Labrador. He reported no significant differences. In contrast to Ryan's findings, Barbour and Mulcahy (2006) investigated differences in students' retention and achievement in AP curriculum across Newfoundland and Labrador via three different delivery methods: Classroom-based, Web-based, and Independent study. They concluded that, "while a smaller percentage of rural students complete their web-based AP course, and even fewer challenge the AP exam, those that do challenge the AP exam tend to perform better than their rural classroom and their urban counterparts (p. 12)."

Summary

The research literature on rural and urban achievement differences highlights that the experiences of rural and urban students are different, and generally that the differences favor urban students. Consequently, urban students tend to outperform rural students. The disadvantaging experiences of rural students identified in the preceding paragraphs are socioeconomic status, the number of students with minority group status, educational resources available to schools, students' attitude towards academics, teachers' qualifications and course offerings. It would be expected therefore that any comparison of rural and urban student academic performance would reveal an urban advantage. If on the other hand, a comparison of rural and urban student achievement across differing delivery methods revealed no differences between groups, this would suggest that the delivery methods lessened the disadvantaging experiences of rural students. It is toward that purpose that I have compared student achievement in the following four comparison groups. The UST_L2C_L3C Group, which I have identified as a control group, is composed of urban students who are not affected by the disadvantaging experiences of rural students. It would be expected that the other three groups that are composed of rural students only, would be affected by the rural disadvantaging experiences. However, because each of those groups engaged in differing course delivery methods, I was able to determine whether course delivery method mitigated these rural disadvantages.

CHAPTER 3: METHODS

Data Manipulation

The data used to perform this study came from the Department of Education, Newfoundland and Labrador and the Center for Distance Education and Innovation (CDLI). This study analyzed academic achievement for those students who started high school in the 2002-2003 school year and graduated during the 2004-2005 school year. This particular cohort was selected because at the time of this study, the 2004-2005 data were the most current available. It was essential to explore the achievement levels of one cohort of students over a three year period because the study purpose was not only to determine if there were student achievement differences between classroom-based and web-based science courses, but also to determine if any differences in students' science achievement between the different delivery methods varied according to students' level of experience with the particular delivery method. In order to reduce the number of confounding factors that may influence science achievement, I restricted the amount of student variability. Students had to be progressing through Level I to Level III within the same time period and they had to have graduated successfully from high school after the completion of their third year.

The data used in the analyses were stored in four different sets of files. The first set of files, which came from the Department of Education, contained school descriptive information. From these files, the following descriptors were utilized:

- school name
- school identification number

- community
- grade structure
- rural-urban indicator

The rural-urban indicator in these documents was developed by the Department of Education, Newfoundland and Labrador. Their definition was based on whether the community in which the physical school existed was rural or urban. More specifically, the Department's definition for the rural-urban indicator was based on a definition of urban community. There are three different urban categories for urban areas within Newfoundland and Labrador: "Census Metropolitan Area (CMA), Census Agglomerations (CA) and other communities 5,000 and over" (Department of Education, NL, 2008, p. 89). Areas not included in the above categories are all considered rural. This definition was problematic for this particular study because often students from rural communities are bused to schools located in urban communities. For example, according to the Department of Education's urban definition, Port de Grave with a population just under 800 is a rural community (Port de Grave Harbour Authority, 2005). However, students from Port de Grave are bussed to Ascension Collegiate in the community of Bay Roberts (Eastern School District of Newfoundland and Labrador, Transportation Information, 2008). Bay Roberts, under the Department's definition would be considered urban and would be categorized under other urban communities with a population over 5,000 people (see Table 1).

Table 1: Census Metropolitan Area, Census Agglomerations and Communities of 5,000 & over Newfoundland and Labrador, 2001 Census

Area	Community	Population
St. John's (CMA)		172,918
	Bauline	364
	Bay Bulls	1,014
	Conception Bay South	19,772
	Flatrock	1,138
	Logy Bay-Middle Cove-Outer Cove	1,872
	Mount Pearl	24,964
	Paradise	9,598
	Petty Harbour-Maddox Cove	949
	Portugal Cove-St. Phillip's	5,866
	Pouch Cove	1,669
	St. John's	99,182
	Torbay	5,474
	Witless Bay	1,056
Corner Brook (CA)		25,747
	Corner Brook	20,103
	Humber Arm South	1,800
	Irishtown-Summerside	1,304
	Massey Drive	770
	Meadows	676
	Mount Moriah	700
	Steady Brook	394
Gander (CA)		11,254
	Appleton	576
	Gander	9,651
	Glenwood	845
	Division No. 6, Subd. E	182
Grand Falls-Windsor (CA)		18,981
	Badger	906
	Botwood	3,221
	Grand Falls-Windsor	13,340
	Northern Arm	375
	Peterview	811
	Division No. 6, Subd. C	328
Labrador City (CA)		9,638
	Labrador City	7,744
	Wabush	1,894
Other areas (population > 500)		
	Bay Roberts	5,237
	Clarenville	5,104
	Happy Valley-Goose Bay	7,969
	Marystown	6,742
	Placentia	5,908
	Stephenville	7,109

In this study, I am exploring the impact of CDLI's web-based courses on the achievement of rural students. As described earlier in this chapter, students within the same school will experience similar school-level disadvantaging experiences. Therefore, students in Port de Grave and Bay Roberts should be categorized as belonging to an urban school. As a result, a new rural-urban indicator was used in this study. The new rural-urban indicator was created through a collaboration of educators from Memorial University who were considered experts in understanding the uniqueness of school populations in Newfoundland that confound the standard Department of Education categorizations noted above. These educators were asked to classify each school as either rural or urban. After the data were collected, Dr. Seifert, a professor within the Education Faculty at Memorial University, performed a latent class analysis to construct the new rural-urban indicator (Seifert, personal communications, July 20, 2008). After the rural-urban indicator was established, the grade structure variable was changed into a new variable that indentified whether or not a particular school was K-12 school. The second set of files, which were also provided by the Department of Education, contained student level data from which the following descriptors were utilized:

- school name
- school identification number
- course name
- course identification number
- proxy number
- sex
- final grade

The third, and final file, provided by the Department of Education, was the 2005 graduate file. This file identified, using proxy numbers, all the students that graduated in June

2005. In the fourth and final set, CDLI provided a set of documents that listed all the courses by school.

In order to determine whether students in web-based science courses performed at least as well as students enrolled in classroom-based science courses, these files had to be merged and students had to be tracked over the three years they were in high school. In order to track students and merge the files, I had to systematize the progression of students through different schools during September 2002 and June 2005; this process was complicated by school restructuring. I completed this task by merging the school-level files for each of the three consecutive years by the school identification number. There were cases within this newly merged file that did not merge because identification numbers did not match for each of the three years. This mismatch was caused either by school closures, missing school identification numbers, or incorrect school identification numbers. To resolve these problems, I used the School Changes documents which are located on the Department of Education website for each school year involved in this study (Newfoundland and Labrador, Department of Education 2002; 2003; 2004). First, I used these documents to match schools that were closed to the new or replacement school that existed the following year. For example, Holland's Memorial was closed after the 2002–2003 school year, and the students from Holland's Memorial went to Gros Morne Academy. Therefore, in the merged file, the 2002–2003 record for Holland's Memorial has to match with the 2003–2004 record for Gros Morne Academy. The second step was to resolve the problem of missing school identification numbers. Schools that had missing identification numbers were replaced by the most logical school identification numbers based on the available data. For example, if a school with an identification number 235 was present for the 2002–2003 and the 2004–2005 school years, I assumed that the school identification number for the 2003–2004 school year had to be 235. The third step in this process involved reassigning a few school identification numbers that were recorded incorrectly. For example, in the Exploits Valley region, the school description data file contained 145 for the school identification numbers during the 2002-2003 and 2003-2004 school years, and 141 for the 2004–2005 school year. This numbering is incorrect because the school identification number 141 and 145 pertain to Exploits Valley High-Greenwood which has grades 9-10 and Exploits Valley High-Maple which has grades 11-12, respectively. Students who started Level I September 2003 would be in Exploits Valley High-Greenwood followed by Exploits Valley High-Maple for Level II and III. Therefore, the school identification numbers were changed to match this sequence. Finally, the fourth step involved the removal of students whose school progression could not be tracked. The only students that could not be tracked were from schools whose school identification number was recorded as Privately Supervised Candidates. Since I could not identify which schools these students attended in subsequent years, I removed these students from the study. A list of all assumptions and changes to school identification numbers can be found in Appendix C. These changes to the school identification number were essential because the rural-urban indicator was merged by the school identification number. Furthermore, students were selected for this study if they attended high school in September 2002 and graduated in June 2005.

To determine which students started high school in September 2002 and graduated in June 2005, I merged the three student level files and the 2005 graduation file. In order to effectively track students over the above noted three years, I created dummy variables in each of the three student level data sets. The dummy variables, all of which were given different names were assigned a value of I, II, and III for 2002-2003, 2003-2004, and 2004-2005 school years. The three student level files and the 2005 graduation file were merged by proxy numbers and a new variable was created in the merged file which was the sum of all three dummy variables from each student level file. If this new variable was not equal to six then the students were not present for all three years and, therefore, were removed from the study. As well, students were eliminated from the study if they did not successfully graduate during their third year of high school. This process created a new data set which contained students' proxy numbers along with students' corresponding school identification numbers for each of the three years. Subsequently, this larger file which contained information pertaining to students' progression through high school was split into three separate files which contained proxy numbers and school identification numbers for each of the three years. These files were the starting point for creating a larger student level file with the addition of CDLI and school information.

The first step in creating the student level data file was to merge the school-level data files into the files which displayed the proxy numbers for students being studied. These files were merged by the school identification numbers for each year of the study. The second step involved merging in the student level files which contained courses and grades; this merger was done through the students' proxy numbers. The final step was to use the CDLI files to determine which courses in specific schools were offered through distance education.

The CDLI files were used to differentiate between classroom-based and web-based courses. The CDLI files were restructured to contain schools, courses, and a distance education flag. The distance education flag was assigned a value of 1 to indicate that the courses were offered through CDLI. Within these CDLI files, the only possible variable that could be used to merge CDLI files into the student level file was school names. Unfortunately, the format of the school names in the CDLI file differed from that in the student level file and; therefore, the files could not be merged directly through this variable. As a result, I had to manually add the appropriate school identification numbers to all the schools in each CDLI file. Once the CDLI files contained school identification numbers, the new rural-urban indicators were merged into the data files. If there were any missing rural-urban indicators, the missing value was replaced by the Department of Education's rural-urban indicator. After the rural-urban indicator was merged with the distance indicator, it became apparent that no urban students were enrolled in web-based distance education physics or chemistry courses (see Table 2). Finally, the CDLI files

Table 2: Cross-tabulations between Rural-Urban Indicator and Distance Education Flag

Distance Education Flag	Rural-Urban Indicator	
	Rural	Urban
Classroom-based	2862	4319
Web-based	268	0

were merged into the student level files by school identification numbers and course identification numbers.

The merging of the student level files, school-level files, and CDLI files for each school year resulted in three data sets which contained the following variables:

- student proxy numbers
- course identification numbers
- grades
- level iii graduate indicator
- distance education indicator
- school names
- school identification numbers

After these data sets were created for each of the three years, they had to be appended. However, cases from each of the three data sets had to be distinguishable. Therefore, a variable was created to represent the students' grade level in each of the three data files. This variable was assigned a value of 1, 2, and 3 in the 2002-2003, 2003-2004, and 2004-2005 data sets, respectively, which corresponds to students being enrolled in Level I, Level II, and Level III, respectively. After appending the data files, the new working data set was ready to be manipulated to perform specific analyses.

Before I could start analyzing by data, I had to remove any cases that contained information that was not related to my research question. Therefore, I removed cases from the working data set that did not correspond to a science course. The removal of these cases was necessary in order to determine whether students enrolled in web-based distance science courses were achieving at levels at least comparable to students enrolled in the traditional classroom-based science courses. As well, in order to compare science achievement in the two different delivery methods, a specific science course had to be offered through both delivery methods. Therefore, if a specific science course was never offered through CDLI throughout the study period, I removed cases that contained that course. To determine which cases had to be deleted, I computed a cross-tabulation between science courses and the distance education indicator as shown in Table 3.

The results of this analysis revealed that Physics 2204, Physics 3204, Chemistry 2202 and Chemistry 3202 were the only science courses that were offered through CDLI during this time period. Finally, in order to decrease the number of exogenous variables, I split the working data file into two separate files: one file related to physics courses and another to chemistry courses. Therefore, the remainder of the data manipulations and analysis discussed in this report were repeated twice, once in each data set.

In this study, it was essential to decrease the variability in students' background characteristics. Therefore, I selected only those students that began high school in September 2002 and graduated June 2005. As well, I selected only those students who did not repeat any of the courses being analyzed. This selection process ensured that students in my sample were in high school during the same time period, were approximately the same age, and had a similar level of experience with the specific subject areas. By minimizing the amount of variation in student background characteristics, I decreased the amount of influence that endogenous variables had on the average student achievement within the four groups; thereby, minimizing the amount of unexplained variance.

Table 3: Cross-tabulations between Science Courses and Distance Education Flag

Course	Classroom-based	Web-based	Total
Science 1200	35	0	35
Science 1206	2618	0	2618
Science 2200	91	0	91
Biology 2201	2825	0	2825
Chemistry 2202	2554	62	2616
Physics 2204	1776	69	1845
Physical Science 2205	211	0	211
Science/Technology/Society 2206	533	0	533
Science 2210(Pilot Course)	24	0	24
Earth Science 2223	82	0	82
Planetary Science 2229	12	0	12
Biologie 2231	1	0	1
Chimie 2239	3	0	3
Science 2260	1	0	1
Physical Science (M) 2265	5	0	5
Science/Technology/Society 2266	9	0	9
Biology 3201	3046	0	3046
Chemistry 3202	1865	82	1947
Physics 3204	985	62	1047
Environmental Science 3205	1487	0	1487
Earth Systems 3209	0	0	0
Science 3210 (Pilot Course)	21	0	21
Biologie 3231	4	0	4
Sciences De L'environnement 3235	4	0	4
Environmental Science 3265	23	0	23
Biology (IB) 3287	27	0	27
Biology (AP) 4221	57	0	57
Chemistry(AP) 4222	31	0	31
Physics (AP) 4224	19	0	19
Biology (IB) 4281	21	0	21
Physics (IB) 4287	12	0	12

In order to accomplish the minimization of variability in students' background characteristics as described above, I first established student deletion criteria. Students were removed from the analysis if they failed to meet the following criteria:

1) If they did not enroll in both the Level II and III science courses (or)

2) If they were enrolled in either the Level II and III science course more than once.

Then, I computed another cross-tabulation between science courses and the distance education indicator. This computation revealed that there were both rural and urban students who completed both science courses in a classroom-based environment. As well, there was a group of rural students that completed the Level II science course in a classroom-based environment and then completed the Level III science course through CDLI. Finally, there was another group of rural students that completed all their science courses through CDLI; that is, Level II and Level III science courses. These groups were the same in both the physics student level data set and the chemistry student level data set. Hence, I created a new variable—Rural-Urban Distance Education Indicator—in the data sets that reflected these categories. The possible values for the Rural-Urban Distance Education Indicator were 0, 1, 2, and 3 which led to the construction of my four groups discussed in Chapter 1 (see Table 4). After these four manipulations were

Table 4: Rural-Urban Distance Education Indicator

Value	Group Label	Meaning
0	UST_L2C_L3C Group	Urban students enrolled in no distance education courses
1	RST_L2C_L3C Group	Rural students enrolled in no distance education courses
2	RST_L2C_L3D Group	Rural students enrolled in one distance education course in Level III
3	RST_L2D_L3D Group	Rural students enrolled in two distance education courses

performed on the two student level files (physics student level file and chemistry student level file), the remaining cases in each of the data files were ready to be analyzed.

The rural-urban distance indicator was used to classify chemistry students and physics into groups that were discussed in the introduction (see page 9). In respect to the chemistry groups (UST_L2C_L3C Group, RST_L2C_L3C Group, RST_L2C_L3D, and RST_L2D_L3D Group), there were 1112, 614, 43, and 33 students in each group, respectively. For the physics groups (UST_L2C_L3C Group, RST_L2C_L3C Group, RST_L2C_L3D, and RST_L2D_L3D Group) there were 664, 250, 42, and 21 students in each group, respectively. Descriptive statistics for the achievement levels of the above noted chemistry and physics groups are shown in Table 5 and Table 6. These tables contain measurements of central tendency and normality.

Table 5: Descriptive Statistics for Chemistry

Chemistry Groups	Grade Level	Sample Size	Mean	Standard Deviation	Skewness	Kurtosis
UST_L2C_L3C Group	II	1122	78.15	11.28	-0.43	-0.35
	III	1122	68.98	13.69	-0.34	-0.28
RST_L2C_L3C Group	II	614	77.09	11.40	-0.45	-0.43
	III	614	64.78	13.70	-0.06	-0.54
RST_L2C_L3D Group	II	43	75.47	10.90	-0.10	-0.20
	III	43	60.77	15.90	0.30	-0.84
RST_L2D_L3D Group	II	33	79.42	12.60	-0.09	-1.33
	III	33	67.39	18.65	-0.67	-0.28

Table 6: Descriptive Statistics for Physics

Physics Groups	Grade Level	Sample Size	Mean	Standard Deviation	Skewness	Kurtosis
UST_L2C_L3C Group	II	664	76.41	11.09	-0.30	-0.59
	III	664	70.22	14.67	-0.41	-0.35
RST_L2C_L3C Group	II	250	75.124	10.98	-0.23	-0.81
	III	250	65.88	15.28	-0.44	-0.13
RST_L2C_L3D Group	II	42	77.69	11.65	-0.64	-0.29
	III	42	66.76	16.78	-0.56	0.60
RST_L2D_L3D Group	II	21	75.57	11.71	0.07	-0.95
	III	21	71.90	15.58	-0.32	-1.14

Model

The variables in the model developed for this study are listed in Table 7 below. These variables were used to determine the answers to the following four research questions that are central to the purpose of this study:

1) Are there differences in student achievement in the Level II science courses between the control group and the other groups?
2) Are there differences in student achievement in the Level III science courses between the control group and the other groups?
3) Are there differences in student achievement between the Level II and Level III science courses within the groups?
4) If question three reveals differences, are these differences attributed solely to the different course levels or do the differences vary for the groups?

The four questions were developed to identify any differences that may exist. It is conceivable that there are differences in the science achievement at both Level II and Level III between the differing groups (Questions 1 and 2). Furthermore, independent of the groups, there may be differences in achievement levels as students progress from the

Table 7: Model Variables

Student level variables	Course level variables	School-level variables
Proxy Number	Distance Flag	School Identification Number
Gender	Course Number	K-12 Indicator
Final Grade	Grade Level	Rural-Urban Indicator
Rural-Urban Distance Education Indicator		
Year Indicator		

Level II science courses to the Level III science courses (Question 3). Finally, and perhaps the most interesting question is Question 4 which is dependent upon whether or not differences are revealed in Question 3. If there are differences between student achievement in the different grade levels, these differences may not manifest in the same manner for each group; that is, achievement differences associated with grade level may be affected by the differing groups, as well. Therefore, I used a general linear model with a repeated measures component to analyze the data. The repeated measures enabled me to insert two dependent variables which reflected students' final grade in the Level II and Level III science courses. The model designed in this study attempts to explain the variances in the final grades through the use of two independent variables, Rural-Urban Distance Education Indicator and the Grade Level, and the interaction between these two predictors. In this model, the first predictor, Rural-Urban Distance Education Indicator, establishes my four chemistry and physics groups; while the second predictor determines whether the students were enrolled in a Level II or Level III science course. The interaction of the differing groups and differing grade levels relates to Question 4 above and is centered on determining the answer to the following question: "If these variables are considered together do they have a different relationship with the final grades than the variables have independently?" To perform these analyses I used the proc mixed procedure in SAS. I chose the proc mixed procedure instead of proc glm because proc glm is restrictive in respect to the availability of multiple comparison tests. In order to determine the best repeated measures general linear model for fitting my data in proc mixed, I completed model comparisons. I compared models with different variance-covariance matrices for both the chemistry and physics data. The best repeated measures general linear model would have the lowest value for the following fit statistics: -2 Log Likelihood, Akaike's Information Criterion (AIC), AIC_C, and Bayesian Information Criterion (BIC) (UCLA Academic Technology Services, Statistical Consulting Group, n.d.). As well, I used multiple comparison tests with a Dunnett adjustment for unequal sample size to answer each of my research questions as noted above. These multiple comparison tests allowed me to determine which groups differed from the UST_L2C_L3C Group in achievement while enrolled in the Level II chemistry and physics courses. As well, it allowed me to determine which groups differ from the UST_L2C_L3C Group in achievement while enrolled in the Level III chemistry and physics courses. Finally, it allowed achievement comparisons of each group as students transitioned from Level II to Level III chemistry and physics courses. For all of these multiple comparison tests, in order to minimize Type1 error, I used the Bonferroni adjustment to change the p-value from 0.05 to 0.005 in the determination of statistically significant differences between groups. To determine the magnitude of any group difference (effect size), I used Hedges' g with the pooled standard deviation for unequal sample size (Ender, 2003).

CHAPTER 4: RESULTS

Chemistry Achievement

Goodness of Fit

The variance-covariance matrix that produced the best fit for both data sets was unstructured. The -2 Log Likelihood, Akaike's Information Criterion (AIC), AIC_C, and Bayesian Information Criterion (BIC) were at their smallest value for the model with an unstructured variance-covariance matrix for the chemistry model (See Table 8). The -2 Log Likelihood, AIC, AIC_C, and BIC were 26919.4, 26941.4, 26941.4, and 27001.9 respectively. The Null Model Likelihood Ratio Test revealed that the variance explained by the unstructured variance covariance model is better than the null model (χ^2(2, N=1812)=1754.17, $p < 0.05$).

Table 8: Chemistry Models

Variance-Covariance structures	-2 Log Likelihood	AIC *	AIC_C *	BIC*
Autoregressive	27097.6	27117.6	27117.7	27172.7
Compound Symmetry	27097.6	27117.6	27117.7	27172.7
Toeplitz	27097.6	27117.6	27117.7	27172.7
Unstructured	26919.4	26941.4	26941.4	27001.9

*smaller is better

General Linear Model: Fixed Effects

The mixed model used in this study revealed that there were achievement differences between the groups for chemistry students ($F(3, 1808)=8.60$, $p<0.05$). As well, there were achievement differences as students progressed from Level II chemistry to Level III chemistry ($F(1, 1808)=545.11$, $p < 0.05$). Finally, the analysis revealed that there were significant interaction effects between the groups and the science grade level for chemistry students ($F(3, 1808)=21.12$, $p < 0.05$). The significant interaction effects mean that students in each of the four groups do not experience the same change in achievement as they progress from Level II chemistry to Level III chemistry. The results of the general linear model were not specific enough to answer the four research questions, however; therefore, I relied on the multiple comparison tests to provide a more precise way of understanding the differences between and within the groups. In the following section, the results related to chemistry achievement are presented.

Multiple Comparison Tests for Chemistry Achievement

Multiple comparison tests were used to answer this study's research questions as they specifically relate to high school chemistry courses:

1) Are there differences in student achievement in the Level II chemistry between the control group and the other groups?

2) Are there differences in student achievement in the Level III chemistry between the control group and the other groups?

3) Are there differences in student achievement between the Level II and Level III chemistry courses within the groups?

4) If question three reveals differences between the Level II and Level III chemistry courses, are these differences attributed solely to the different course levels or do the differences vary for the groups?

The results of the above noted multiple comparison tests along with the associated effect sizes are reported in Table 9. Table 9 is followed by Table 10 which displays the means for Chemistry 2202 and Chemistry 3202 achievement for each group. Finally, Figure 1 is a graph of the means as displayed in Table 10; it represents the achievement

Table 9: Differences in Chemistry Achievement

Row #	Within	Between		Mean Differences	Df	T	P	ES
1.(a)	Chemistry 2202	RST_L2C_L3C	UST_L2C_L3C	-1.0621	1808	-1.87	0.3394	0.09
1.(b)	Chemistry 2202	RST_L2C_L3D	UST_L2C_L3C	-2.6882	1808	-1.53	0.5827	0.24
1.(c)	Chemistry 2202	RST_L2D_L3D	UST_L2C_L3C	1.2709	1808	0.64	0.9922	0.11
2.(a)	Chemistry 3202	RST_L2C_L3C	UST_L2C_L3C	-4.2020	1808	-6.05	<.0001	0.31
2.(b)	Chemistry 3202	RST_L2C_L3D	UST_L2C_L3C	-8.2147	1808	-3.82	0.0009	0.60
2.(c)	Chemistry 3202	RST_L2D_L3D	UST_L2C_L3C	-1.5882	1808	-0.65	0.9905	0.11
3.(a)	UST_L2C_L3C	Chemistry 2202	Chemistry 3202	9.1711	1808	35.23	<.0001	0.73
3.(b)	RST_L2C_L3C	Chemistry 2202	Chemistry 3202	12.3111	1808	34.99	<.0001	0.98
3.(c)	RST_L2C_L3D	Chemistry 2202	Chemistry 3202	14.6977	1808	11.05	<.0001	1.08
3.(d)	RST_L2D_L3D	Chemistry 2202	Chemistry 3202	12.0303	1808	7.93	<.0001	0.76

Table 10: Mean Achievement for Chemistry Groups

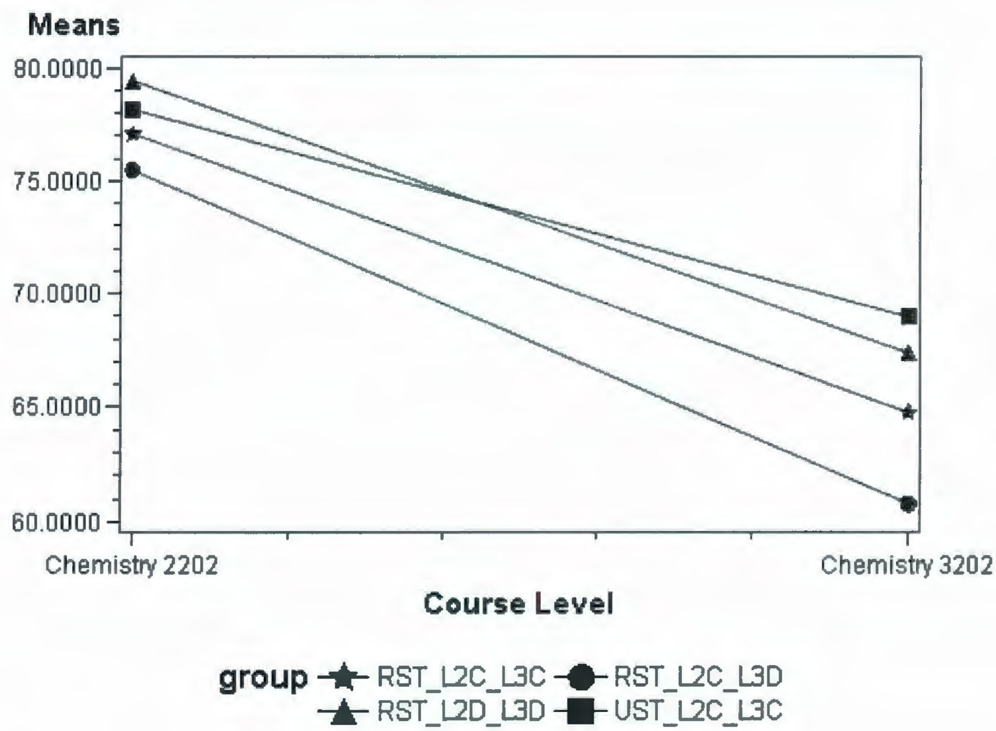
Chemistry Groups	Group Definitions	Chem2202 Achievement	Chem3202 Achievement
Control Group	*Urban students enrolled only in classroom-based chemistry courses*	78.15	68.98
RST_L2C_L3C	*Rural students enrolled only in classroom-based chemistry courses.*	77.09	64.78
RST_L2C_L3D	*Rural students enrolled in classroom-based Chemistry 2202, and web-based Chemistry 3202*	75.47	60.77
RST_L2D_L3D	*Rural students enrolled only in web-based chemistry courses*	79.42	67.39

levels of the four chemistry groups as the students progress from Chemistry 2202 to Chemistry 3202.

In order to answer questions 1 and 2, multiple comparison tests were computed within Chemistry 2202 and Chemistry 3202 between the control group (UST_L2C_L3C Group) and the RST_L2C_L3C Group, the RST_L2C_L3D Group, and the RST_L2D_L3D Group. As shown in Rows 1a -1c of Table 9, there were no achievement differences between the control groups and the comparison groups for Chemistry 2202. This result is apparent in Figure 1 as the lines representing Chemistry 2202 achievement levels for each group appear close together. However, Figure 1 reveals that when these same students enrolled in Chemistry 3202 in the subsequent year, there were differences in achievement between the control group and the comparison groups. While the control group (UST_L2C_L3C Group) and the RST_L2D_L3D Group have the highest Chemistry 3202 average and are in approximately the same location in Figure 1, it is obvious from the graph that neither the RST_L2C_L3C Group and the RST_L2C_L3D Group perform as well as the RST_L2D_L3D or the control group. Furthermore, it can be seen that the RST_L2C_L3D Group has the lowest Chemistry 3202 grade. These differences are displayed more specifically in Table 9 (Rows 2a-2c). It can be seen in Row 2a that there was a moderately small achievement difference (ES=.31) between the control group and the RST_L2C_L3C Group ($t(1808)=-6.05$, $p<0.005$). As well, there existed a medium achievement difference with an effect size of 0.60 as shown in Row 2b between the control group and the RST_L2C_L3D Group ($t(1808)=-3.82$, $p<0.005$).

However, there was no achievement difference between the control group and the RST_L2D_L3D Group (see Row 2c).

Figure 1: Chemistry Achievement



To answer Questions 1 and 2 above, I explored achievement differences between the control and the comparison groups for both chemistry courses; however, the next question, Question 3, required an exploration of achievement differences between Chemistry 2202 and Chemistry 3202 that exists within the control group and the comparison groups. To that end, I computed multiple comparison tests within the differing chemistry groups between Chemistry 2202 and Chemistry 3202 as shown in Rows 3a -3d of Table 9. As seen in Table 9 Row 3a and Row 3d, there was a medium drop in achievement as chemistry students in the control group ($t(1808) = 35.23$, $p < 0.005$) and the RST_L2D_L3D Group ($t(1808) = 7.93$, $p < 0.005$) progressed from Chemistry 2202 to Chemistry 3202 with an effect size of 0.73 and 0.76, respectively. As well, Table 9 Row 3b and Row 3c reveal large achievement differences between Chemistry 2202 and Chemistry 3202 in the other two groups (RST_L2C_L3C and RST_L2C_L3D). This large achievement difference is represented by an effect size of 0.98 for the RST_L2C_L3C Group ($t(1808) = 34.99$, $p < 0.005$) and an effect size of 1.08 for the RST_L2C_L3D Group ($t(1808) = 11.05$, $p < 0.005$). These drops in achievement from Chemistry 2202 to Chemistry 3202 are evident in Figure 1 as it can be seen that the lines representing the average grade drop for each group.

In answering Questions 1-3, I investigated differences within chemistry courses (Questions 1 and 2) and within chemistry groups (Question 3). In answering Question 4, I investigated the achievement differences that were caused by the interaction of the differing groups and grade level on each other. In the above section entitled, General Linear Model: Fixed Effects, I have already found a significant interaction in chemistry ($F(3, 1808) = 21.12$, $p < 0.05$). This interaction effect can be explained further through the results of the multiple comparison tests that revealed that there were no achievement differences between the control group and the comparison groups while students were enrolled in Chemistry 2202. As well, I have previously determined that student achievement levels decreased as they moved from Chemistry 2202 to Chemistry 3202. If these achievement drops had nothing to do with the groups, it would be expected that the achievement drop from Chemistry 2202 to Chemistry 3202 would be the same for all groups. If this were the case, there would be no difference in Chemistry 3202 achievement levels between the control group and the comparison groups because chemistry students in the differing groups were originally achieving at the same level as students in the control group while enrolled in Chemistry 2202. However, this was not the case. There were variations in the Chemistry 3202 achievement levels between the control group and the comparison groups. Therefore, the multiple comparison tests support the conclusion that within chemistry there was an interaction effect between the differing groups and the grade level, as can be observed clearly in Figure 1, as well. As can be seen the achievement lines for each group are not parallel, thereby indicating an interaction effect between the differing groups and the grade level. If the drop in achievement experienced between Chemistry 2202 and Chemistry 3202 was independent of the differing groups, the lines would be parallel.

Physics Achievement

Goodness of Fit

The variance-covariance matrix that produced the best fit for both data sets was unstructured. The -2 Log Likelihood, Akaike's Information Criterion (AIC), AIC_C, and Bayesian Information Criterion (BIC) were at their smallest value for the model with an unstructured variance-covariance matrix for the physics model (See Table 11). For the physics model, the -2 Log Likelihood, AIC, AIC_C, and BIC were 14677.2, 14699.2, 14699.4, and 14753.0 respectively. As well, the Null Model Likelihood Ratio Test revealed that the variance explained by the unstructured variance-covariance model is better than the null model ($\chi^2(2, N=977)=932.54$, $p<0.05$).

Table 11: Physics Models

Variance-Covariance Structures	-2 Log Likelihood	AIC	AIC_C	BIC
Autoregressive	14868.7	14888.7	14888.8	14937.5
Compound Symmetry	14868.7	14888.7	14888.8	14937.5
Toeplitz	14868.7	14888.7	14888.8	14937.5
Unstructured	14677.2	14699.2	14699.4	14753.0

*smaller is better

General Linear Model: Fixed Effects

The mixed model used in this study revealed that there were achievement differences between the groups for physics students ($F(3, 973)=3.29$, $p<0.05$). As well, there were achievement differences as students progressed from Level II physics to Level III physics ($F(1, 973)=125.39$, $p<0.05$). Finally, the analysis revealed that there were significant interaction effects between the groups and the science grade level for physics students ($F(3, 973)=9.17$, $p<0.05$). The significant interaction effects mean that students in each of the four groups do not experience the same change in achievement as they progress from Level II physics to Level III physics. The results of the general linear model were not specific enough to answer the four research questions. Therefore, I relied on the multiple comparison tests to provide a much more robust way of understanding the differences between and within the groups. In the following section, the results of the physics are presented.

Multiple Comparison Tests for Physics Achievement

As with chemistry, multiple comparison tests were used to answer my research questions as they specifically relate to high school physics courses:

1) Are there differences in student achievement in the Level II physics between the control group and the other groups?

2) Are there differences in student achievement in the Level III physics between the control group and the other groups?

3) Are there differences in student achievement between the Level II and Level III physics courses within the groups?

4) If question three reveals differences between the Level II and Level III physics courses, are these differences attributed solely to the different course levels or do the differences vary for the groups?

For comparative purposes and to maximize consistency, the data displays that were created for the chemistry groups were created for the physics groups, as well. To this end, Table 12 shows the results of the multiple comparison tests along with the associated effect sizes for physics; Table 13 displays the mean Physics 2204 and Physics 3204 achievement for each group, and Figure 2 is the graph of the means in Table 13 that displays the achievement levels of the four comparison groups as the students progress from Physics 2204 to Physics 3204.

In order to answer Questions 1 and 2, multiple comparison tests were computed within Physics 2204 and Physics 3204 between the control group and the comparison groups. As shown in Rows 1a -1c of Table 12 and displayed graphically in Figure 2, similar to the Level II chemistry students, the Level II physics students in comparison groups achieved at the same level as the Level II physics students in the control group.

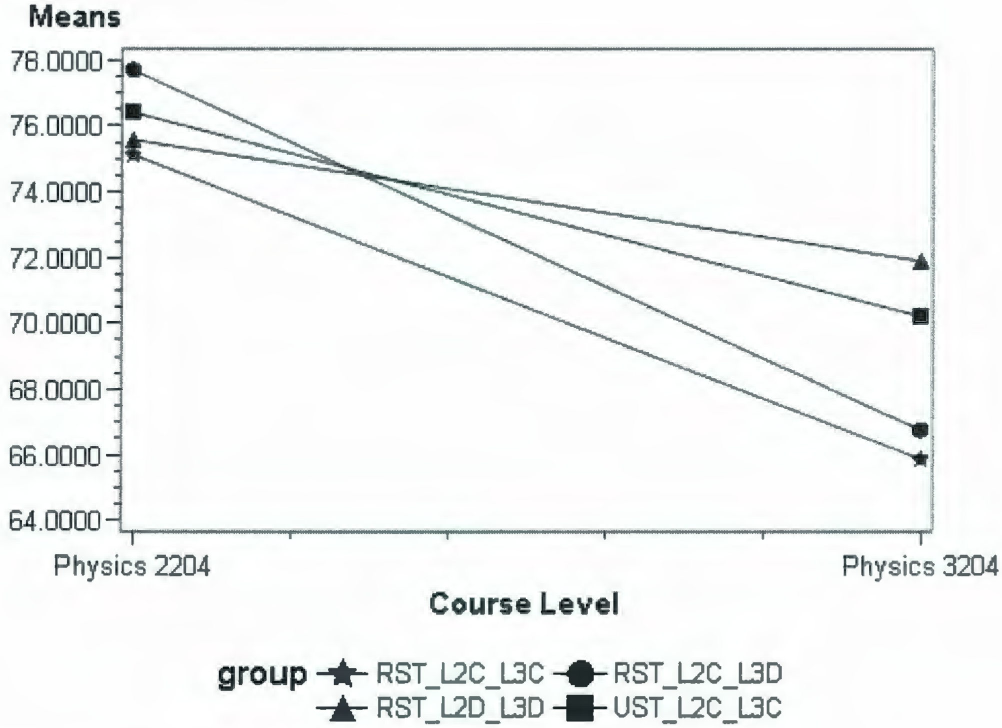
Table 12: Differences in Physics Achievement

Rows	Within	Between		Mean Differences	Df	T	P	ES
1.(a)	Physics2204	RST_L2C_L3C	UST_L2C_L3C	-1.2826	973	-1.56	0.5611	0.12
1.(b)	Physics2204	RST_L2C_L3D	UST_L2C_L3C	1.2838	973	0.73	0.9836	0.12
1.(c)	Physics2204	RST_L2D_L3D	UST_L2C_L3C	-0.8352	973	-0.34	0.9999	0.08
2.(a)	Physics3204	RST_L2C_L3C	UST_L2C_L3C	-4.3454	973	-3.93	0.0006	0.29
2.(b)	Physics3204	RST_L2C_L3D	UST_L2C_L3C	-3.4595	973	-1.46	0.6231	0.23
2.(c)	Physics3204	RST_L2D_L3D	UST_L2C_L3C	1.6834	973	0.51	0.9978	0.11
3.(a)	UST_L2C_L3C	Physics2204	Physics3204	6.1852	973	16.49	<.0001	0.48
3.(b)	RST_L2C_L3C	Physics2204	Physics3204	9.2480	973	15.12	<.0001	0.70
3.(c)	RST_L2C_L3D	Physics2204	Physics3204	10.9286	973	7.33	<.0001	0.76
3.(d)	RST_L2D_L3D	Physics2204	Physics3204	3.6667	973	1.74	0.2112	0.27

Table 13: Mean Achievement for Physics Groups

Physics Groups	Group Definitions	Phys2202 Achievement	Phys3202 Achievement
Control Group	*Urban students enrolled only in classroom-based physics courses*	76.41	70.22
RST_L2C_L3C	*Rural students enrolled only in classroom-based physics courses.*	75.12	65.88
RST_L2C_L3D	*Rural students enrolled in classroom-based Physics 2204, and web-based Physics 3204*	77.69	66.76
RST_L2D_L3D	*Rural students enrolled only in web-based Physics courses*	75.57	71.90

Figure 2: Physics Achievement



Similar to the findings for chemistry achievement, there was no achievement difference in Physics 3204 between the control group (UST_L2C_L3C Group) and the RST_L2D_L3D Group. Unlike the performance in Chemistry 3202, however, the only difference that was found between the control group and the comparison groups in Physics 3204 was between the control group and the RST_L2C_L3C Group, ($t(973)=-3.93$, $p<0.005$), with an effect size of 0.29 (See Row 2a, Table 12). As well, unlike the chemistry findings that showed achievement differences between the control group and the RST_L2C_L3D Group, in physics, Row 2b reveals that there was no achievement difference between the control group and the RST_L2C_L3D Group. Figure 2, a graph of these results, presents a clear representation of the findings related to physics achievement of the various groups. It reveals that the control group (UST_L2C_L3C Group), and the RST_L2D_L3D Group have the highest Physics 3204 average and that these averages are similar for both groups as they are approximately in the same location in Figure 2. It can be observed as well, that the RST_L2C_L3C Group has the lowest Physics 3204 achievement in comparison to the other groups. It is not quite so obvious in this figure that there was no achievement difference between the control group (UST_L2C_L3C Group) and the RST_L2C_L3D Group, however. While Figure 2 reveals an apparent difference in the drop between those two groups, the difference is not a statistically significant one.

To answer Questions 1 and 2 above, I explored achievement difference between the control and the comparison groups in both physics courses. The next question, Question 3, required an exploration of achievement differences between Physics 2204 and Physics 3202 that exist within the control group and the comparison groups. To accomplish this, I computed multiple comparison tests within the differing Physics groups between Physics 2204 and Physics 3204 as shown in Rows 3a -3c of Table 12. Table 12, Row 3a reveals that there was a small achievement drop between Physics 2202 and Physics 3204 for physics students in the control group ($t(973)=16.49$, $p<0.005$) with an effect size of 0.48. As well, Table 12, Row 3b and Row 3c reveal that the achievement difference between Physics 2204 and Physics 3204 experienced by the RST_L2C_L3C and RST_L2C_L3D Groups were medium sized drops with an effect size of 0.70 for the RST_L2C_L3C Group ($t(973)=15.12$, $p<0.005$) and an effect size of

0.76 for the RST_L2C_L3D Group ($t(973)=7.33$, $p<0.005$), respectively. Within the control group, the RST_L2C_L3C Group, and the RST_L2C_L3D Group, these drops in achievement from Physics 2204 to Physics 3204 are evident in Figure 2 by the negative slope in the achievement lines. The above results are similar to the findings in chemistry as students in the three aforementioned groups (the control group, the RST_L2C_L3C Group, and the RST_L2C_L3D Group) experienced decreases in achievement from the Level II course to the Level III course. However, unlike chemistry, Table 12, Row 3d indicates that there was no difference in achievement between Physics 2204 and Physics 3204 within the RST_L2D_L3D Group–*rural students enrolled only in web-based physics courses*. This can be seen in Figure 2 as the line representing the RST_L2D_L3D Group does not have a slope that is significantly different from zero.

In answering Questions 1-3, I investigated differences within physics courses (Questions 1 and 2) and within physics groups (Question 3). Similar to chemistry, there could have been achievement differences that were caused by the interaction of the differing groups and grade level on each other; therefore, in answering Question 4, I investigated this possibility. While I have already determined through the fixed effects solutions of the general linear model, that this interaction was significant ($F(3, 973)=9.17$, $p<0.05$) this finding is explained further through the results of the multiple comparison tests. Through these multiple comparison tests, I determined that there were no achievement differences between the control group (UST_L2C_L3C) and the RST_L2C_L3C Group, the RST_L2C_L3D Group and the RST_L2D_L3D Group for Physics 2204. As well, I have determined that student achievement levels decreased as they moved from Physics 2204 to Physics 3204. If these achievement drops had nothing to do with the groups, it would be expected that the achievement drop from Physics 2204 to Physics 3204 would be the same for all groups. If this were the case, there would be no difference in Physics 3204 achievement levels between the control groups and the comparison groups because physics students in the differing groups were originally achieving at the same level as students in the control group while enrolled in Physics 2204. However, once again, similar to my chemistry findings, this was not the case. There were variations in the Physics 3204 achievement levels between the control group and the comparison groups, thereby supporting a conclusion that within physics there was an interaction effect between the differing groups and the grade level. This interaction effect is displayed clearly in Figure 2, as it can be seen that the achievement lines for each group are not parallel.

Summary

Students enrolled in Chemistry 2202 experienced the same achievement levels regardless of their school locality or delivery method; however, this was not the case for Chemistry 3202 where locality and delivery appear to have had considerable impact on achievement levels. As well, on average there was a medium to large drop in achievement for chemistry students as they progressed from Chemistry 2202 to Chemistry 3202. Findings from this study revealed that the magnitude of this drop depended upon locality and/or delivery method. A particularly interesting finding, and I believe an important one, is that there was no achievement difference between urban students enrolled only in classroom-based chemistry courses and rural students enrolled only in web-based chemistry courses, and both experienced the same medium sized achievement drop from Chemistry 2202 and 3202. It is noteworthy, as well, that rural students enrolled in classroom-based Chemistry 2202 experienced a large drop in achievement in Chemistry 3202 irrespective of whether they were enrolled in classroom-based or web-based Chemistry 3202. The largest drop in achievement from Chemistry 2202 to Chemistry 3202 was experienced by rural students who completed Chemistry 2202 that was classroom-based and then completed a web-based version of Chemistry 3202.

Similar to chemistry discussed above, while students enrolled in Physics 2204 experienced the same achievement levels regardless of locality or delivery method, both of these factors appear to have had considerable influence upon achievement in Physics 3204. Rural students who completed web-based versions of both Physics 2004 and Physics 3204 were the only group that did not experience a drop in achievement. All other groups experienced a small to medium drop in achievement. The rural students enrolled in classroom-based Physics 2204 experienced a medium drop in achievement in Physics 3204 irrespective of whether it was web-or classroom-based. Nonetheless, even though rural students enrolled in classroom-based Physics 2204 and web-based Physics 3204 experienced a medium drop in achievement, within Physics 3204, their achievement levels were not different from urban students enrolled only in classroom-based physics courses. This was not the case for rural students who completed both physics courses through a classroom-based approach. The grades for this latter group of students were found to be lower than those of their urban counterparts.

CHAPTER 5: SUMMARY AND DISCUSSION

The results of this study have a number of important implications for web-based distance education courses, particularly those courses offered through CDLI in Newfoundland and Labrador. Employing data made available through the Department of Education, Newfoundland and Labrador, I have explored differences in student achievement in high school chemistry and physics among those who completed the courses in both urban and rural settings through either a web-based distance delivery approach or a classroom-based approach. In this chapter, I provide a summary of the results of my research and discuss the implications of my findings.

Implication 1: Web-based Course Delivery Can Overcome the Rural-Urban Achievement Gap

Among the most salient results from the student achievement data for chemistry and physics are those related to the 3000 level courses, Chemistry 3202 and Physics 3204. It was not particularly unanticipated that there was a difference in student achievement in either of those 3000 level courses favoring urban students over rural students in circumstances where all students completed the course through a classroom-based approach. A particularly compelling finding, however, is that this achievement difference did not exist between urban students who were enrolled in only classroom-based courses and rural students who enrolled in only web-based chemistry and physics courses.

Assuming that collectively the rural students have similar background characteristics, other than having completed their chemistry or physics courses through a web-based approach, it is reasonable to expect that collectively they would be affected similarly by the typical rural disadvantaging experiences as discussed in Chapter 2. Arguably, these rural students have to overcome these disadvantaging experiences in order to be as successful as their urban counterparts. In spite of that, the rural students who were enrolled in only web-based chemistry and physics courses beginning with the 2000 level courses performed at levels comparable to their urban counterparts in both Chemistry 3202 and Physics 3204, while the rural students who were enrolled in only classroom-based chemistry and physics courses did not perform as well in these courses as their urban counterparts. It appears that the web-based distance chemistry and physics courses offered through CDLI were the only observable difference between these two groups of rural students. These results suggest that while there is a rural-urban achievement gap that may, indeed, be perpetuated through various disadvantaging experiences that place rural students at a learning disadvantage, there is nothing innate about rural students that cause them to perform at lower levels than urban students. As a matter of fact, the rural students enrolled in web-based chemistry and/or physics courses delivered through CDLI achieved on par with their urban counterparts in those courses in spite of a well recognized rural-urban achievement gap favoring urban students. Overall, these findings suggest that the traditionally accepted rural-urban achievement gap favoring urban students can be mitigated by the delivery of web-based courses such as those offered by CDLI.

Implication 2: Web-based Course Delivery Is Particularly Important for Success in More Advanced Courses

In this study, I have explored two levels of high school chemistry and physics: Chemistry 2202 and Chemistry 3202 and Physics 2204 and Physics 3204. Both Chemistry 3202 and Physics 3204 extend on the skills and knowledge learned in the respective 2000 level courses. In addition, both 3000 level chemistry and physics courses require students to write a public exam. As a consequence, it is reasonable to assume that the 3000 level courses are more challenging than their 2000 level prerequisites—an assumption that is supported by my results. In chemistry, there were significantly large drops in achievement between Chemistry 2202 and Chemistry 3202 for all groups analyzed. Furthermore, when the differing chemistry groups in my study are pooled in the analysis, overall, the chemistry grades dropped approximately 10 % from Chemistry 2202 to Chemistry 3202, $t(3622) = 24.59$, <0.05. This is clearly a large drop as evidenced by the effect size of 0.82. As with Chemistry 3202, with the exception of rural physics students who enrolled only in web-based physics courses, each physics group had an achievement drop as the students progressed from Physics 2204 to Physics 3204. Specifically, when all physics students were considered as one group, grades dropped approximately 7 % from Physics 2204 to Physics 3204, ($t(1952)= 11.90$, $p<0.05$) a medium drop as indicated by an effect size of 0.54. Recognition of this reality establishes the premise for Implication 2: The rural-urban achievement gap that is exacerbated in more advanced, or more challenging courses, that are subject to provincial common examinations (public examinations) can be mitigated through the delivery of web-based courses.

The differences in difficulty level between the 2000 and 3000 courses and the introduction of a public examination may exacerbate the effect of the disadvantaging experiences related to the rural context upon rural students, thereby resulting in their lower levels of achievement compared to their urban counterpart in Chemistry 3202 and Physics 3204. This appears to have been the case for the students in this study. While there were no achievement differences in either Physics 2204 or Chemistry 2202, there were achievement differences between the control group and the comparison groups in both Physics 3204 and Chemistry 3202. The rural students who enrolled only in classroom-based chemistry and physics courses experienced a larger achievement drop than their urban classroom-based counterparts. In contrast, the rural students who were enrolled in web-based chemistry and physics courses did not experience an achievement drop greater than the urban students. As a matter of fact, beyond that, the rural web-based physics students did not experience any achievement drop at all.

It appears that when students enroll in the more challenging courses in physics and chemistry, the effects of the rural disadvantaging experiences become more pronounced as is evidenced by the lower achievement of the rural students as compared to their urban counterparts in the classroom-based third level chemistry and physics courses. Those rural students who completed only web-based versions of those courses through CDLI were able to overcome the apparent deficits of their rural context and achieve at levels comparable to their urban counterpart in the Level III chemistry and physics courses. To that effect, it appears that the web-based courses offered through

CDLI are more important to students' success in the more challenging courses such as Chemistry 3202 and Physics 3204.

Implication 3: The Need for Engagement of Students in Web-based Prerequisite Courses May Vary by the Degree of Course Complexity and Teacher Qualifications

While my analysis revealed that the use of web-based delivery enabled rural students to achieve at levels comparable to urban students in Physics 3204 and Chemistry 3202, the importance of whether or not students completed the prerequisite course through a web-based or classroom format varied according to the subject area. In this regard, achievement of rural students in Physics 3204 was comparable to that of their urban counterparts providing they completed it in a web-based format. That is, rural students enrolled in web-based Physics 3204 experienced the same achievement level as their urban counterparts irrespective of whether Physics 2204 was completed in web-or classroom-based environment. Contrary to those conditions for success in Physics 3204, however, chemistry student experienced the same achievement level as urban students in Chemistry 3202 only if both chemistry courses were web-based. As a matter of fact, a peculiar and interesting finding is that chemistry students who completed only one web-based chemistry course, that being Chemistry 3202, had the lowest achievement in that course when compared to all other students.

Clearly, success for rural students in Chemistry 3202 was dependent upon their having completed both Chemistry 2202 and Chemistry 3202 through a web-based approach. Below, I propose two possible explanations for this phenomenon.

The first explanation is related to the fact that rural students are often disadvantaged by having fewer qualified science teachers (Dibbon & Sheppard, 2001; Lee & McIntire, 2000). A plausible assumption is that a generalist teacher with only limited expertise in chemistry taught the Chemistry 2202, but did not have the necessary level of knowledge required to teach the more difficult Chemistry 3202 course. In such circumstances, it is entirely possible that students may have had a less than enriching learning experience in Chemistry 2202 that would have poorly prepared them with the prerequisite skills and knowledge needed for Chemistry 3202. A second explanation is directly related to the nature of web-based distance education. As previously discussed in Chapter 1, web-based distance education is a relatively new model of teaching and learning which requires students to work with a higher level of autonomy and responsibility (Barbour & Reeves, 2009; Cavanaugh, Gillan, Kromrey, Hess, & Blomeyer, 2004). Students who take both chemistry courses through CDLI have an opportunity to learn how to learn chemistry in a web-based learning environment before enrolling in web-based Chemistry 3202. On the other hand, students who had no previous experience with learning in a web-based environment may not have developed the necessary technology skills or independent learning skills necessary for success in the web-based Chemistry 3202. While both of those explanations may explain why students who did not complete the prerequisite Chemistry 2202 through a web-based approach struggled with the web-based Chemistry 3202, it does not explain why this was not the case for Physics 3204. One possible explanation for this may be related to the level of difficulty of the courses. Given that Physics 3204 students performed slightly better than the Chemistry 3202 students ($t(1993)=-2.32$, $p<0.05$) with an effect size of 0.09, it might be that students find the chemistry courses more difficult. In light of the fact that the difference between Chemistry 3202 and Physics 3204 achievement is extremely small, however, the accuracy of my speculation requires further investigation.

Findings of this study suggest that the use of a web-based delivery approach is important to rural students as a means of allowing them to perform on par with their urban counterparts. Moreover, the provision of this opportunity to rural students appears to be particularly important if they are to perform on par with urban students in the more challenging 3000 level courses. As well, given the finding that the completion of the 2000 level chemistry through a web-based approach has a positive effect upon the students' success in Chemistry 3202, it may be prudent of policy makers to support the further development of CDLI and to increase the rural student enrolments in 2000 and 3000 level courses in order to provide rural students with equitable educational opportunities.

CHAPTER 6: CONCLUSION

Limitations and Directions for Future Research

Throughout my review of literature, I have discovered that many authors believe that much of the research pertaining to rural education and web-based distance education has had serious limitations because of a lack of adequate control of confounding variables (Reeves and Bylund, 2005; Rice, 2006). In this study, I attempted to overcome the aforementioned limitations through the recognition of four groups: three comparison groups and a control group. The recognition of these groups enabled me to indirectly control for student background characteristics that have been recognized as disadvantaging experiences that negatively impact rural students' educational opportunities. The control group was composed of urban students who generally are not affected by the disadvantaging experiences to the same extent as rural students; therefore, they were the baseline to mark all achievement comparisons. There were two main groups of rural students that enabled the control of the disadvantaging experiences: (1) those who enrolled only in classroom-based chemistry or physics and (2) those who enrolled only in web-based chemistry or physics. By comparing these two groups of rural students to the control group, I was able to indirectly control for the disadvantaging experiences which have been found to often confound much of the research findings related to the achievement of rural students in web-based distance education. A limitation of my study, however, relates to these disadvantaging experiences. I did not have a direct means of controlling the disadvantaging experiences or a direct way of measuring their influence over achievement. While the four groups that I created allowed me to categorize students by the delivery method (web-based or classroom-based) and by location (urban or rural school), the students selected in this study started high school in Newfoundland and Labrador September 2002 and graduated June 2005. Consequently, my study constitutes an isolated observation of one selected cohort of students. As a result, there may be other disadvantaging experiences that are not being controlled. For example, a change in the economy, the school culture, the course selection process, the school administrator approach, and teachers' qualifications or their approach to teaching may impact students' achievement levels. Furthermore, this study was conducted during the initial years of CDLI and there may have been changes in the delivery of web-based courses. A single observation cannot capture or control for all of these possible, yet very influential, disadvantaging experiences.

Essentially, to fully understand whether the teaching and learning methods employed in the web-based distance courses offered through CDLI are as effective as those employed in the classroom-based environment, a longitudinal study of student achievement in classroom-based and web-based environment must be conducted. In such a study, a questionnaire designed to collect descriptive information pertaining to the disadvantaging experiences from the students, their family members, school personnel, and community members throughout the duration of the study would allow the researcher to better control for those factors.

A second limitation relates to the measures of student achievement. While I employed final student grades as documented in the official records of the Department of Education, Newfoundland and Labrador and CDLI, there is no available standardized measure for Level II grades. The final grades in the selected Level III courses provide a relatively standardized measure of achievement for all students because 50% of each grade is determined through provincial public examinations. Notable discrepancies between the public examination grade and the grade assigned by the school are mitigated through a provincial formula that is applied to determine the final grade. For Level II high school courses, however, the only grades available are those assigned by teachers. This opens the potential for differences in grading practices across schools and across teachers in both regular school settings and in CDLI. While recognizing this as a potential limitation, it appears reasonable to assume that any propensity for more lenient or rigid grading practices would vary equally across rural and urban schools and CDLI (Crocker, 2007), and therefore, any variations would likely have little impact on the findings of this study. Additionally, the results of this study appear to support the aforesaid assumption given that within Level II chemistry and physics courses there were no significant achievement differences between groups.

A third limitation relates to the variation in group sample sizes. While I created four groups as a means of controlling the disadvantaging experiences, I did not have the same number of students in each of those groups. The sample size in each group ranged from 1089 chemistry students and 643 physics students in the largest groups to 33 chemistry students and 21 physics students in the smallest groups, respectively. This required that I employ the Dunett adjustment on the p-value for unequal sample sizes. As CDLI continues to grow and the government's data management systems improve as anticipated, some of these challenges will likely be mitigated.

Recommendations

I. Students who enroll in web-based distance education courses for the first time should be provided with a short session that will help them learn how to learn in the web-based environment. The results of this study suggest that first time CDLI students who enroll in web-based science courses, especially web-based Chemistry 3202, experience a drop in achievement. It has been well established that web-based students require greater levels of autonomy and responsibility. I expect that a short session which clearly demonstrates the new expectations in the web-based environment would be beneficial to students.

II. Students who enroll in a Level III web-based science course should be provided with a formative test at the end of the academic year prior to enrolment in that course in order to determine if they have all the prerequisite skills and knowledge to proceed to the Level III course. A mini foundation course could be made available to those students who have demonstrated major gaps in the foundational skills and knowledge, thereby minimizing the difficulty in progression from Level II to Level III science.

III. Specialist teachers must be allocated to the disciplinary area of their expertise at least in the sciences. It is apparent from this study that the negative effect of disadvantaging experiences does not significantly affect students' achievement in the easier Level II science courses; however, when students progress to the respective Level III science courses, there is an achievement drop. If specialist teachers were teaching in their area of expertise, it is likely that the negative effects of the disadvantaging experiences would be reduced.

Final Thoughts

This is a very exciting time in education in Newfoundland and Labrador as CDLI continues to expand in an effort to deal with the educational dilemmas created by the decline in the already dispersed rural and remote communities. With the rapid decline in the student population in the K-12 school system in rural Newfoundland and Labrador, it is challenging to offer the same breadth and quality curriculum to students in many of these communities. In an attempt to deal with these challenges, initially, both the provincial government and school boards focused on consolidating schools and busing students into larger centers. While this strategy mitigated the challenges for a period of time, the continued decline called for alternate solutions as further consolidation was not possible. The primary alternate solution implemented by Newfoundland and Labrador Department of Education has been the establishment of CDLI that was mandated to implement a new model of distance education that "relies on the use of computers, networks and the Internet [and, therefore,]…access is not locked to a prescribed schedule of communications times" (CDLI, 2009).

It has been just under a decade since CDLI commenced operations, and there has been limited research to determine its success. This study was designed to address this circumstance and to contribute to the development of our understandings of the complexity involved in ensuring that the schooling experience of rural students is comparable to that of urban students. In particular, this study focused on the extent to which differing delivery approaches (in-class or web-based) might contribute to offsetting the identified rural factors (socioeconomic status, minority groups, schools' educational resources, students' attitude towards academics, and teacher qualifications) that have been shown to negatively impact upon the achievement levels of rural students. My results revealed there were no differences between rural and urban students' performance level in Level II physics or chemistry courses irrespective of whether or not the delivery mode was classroom-based or web-based. The final grades in Level III courses in physics and chemistry that are partially based on common provincial examinations revealed differences between rural and urban student achievement favoring urban students when rural students completed their programs in their local rural school. This finding is clearly supportive of a conclusion that the mediating rural factors negatively impacted rural students' academic achievement in Level III physics and chemistry. A particularly important finding, however, is that when rural students completed both the Level II and Level III physics or chemistry, they achieved at levels comparable to their urban counterparts. My study results reveal, as well, that the completion of both Level II and Level III courses through CDLI led to improved achievement in both Level III physics and chemistry. As a matter of fact, in chemistry, only those rural students who completed both Level II and Level III chemistry through CDLI performed at levels equal to the urban students. While this was not the case for the web-based Physics 3204 where rural students' achievement was equal to that of urban students irrespective of their having completed the Level II physics through the web. It is noteworthy that those students who completed both Physics 2204 and Physics 3204 through CDLI out performed the urban students in Physics 3204. Actually, this latter group of rural students was the only group who did not experience a drop in their final grade as they moved from Level II to Level III physics. Findings from this study suggest that the completion of web-based courses in physics and chemistry at the high school-level can offset the disadvantaging experiences that have typically resulted in lower achievement levels of rural high school students.

In the absence of rural students enrolling in web-based distance education courses, it appears that students will continue to be adversely affected by the perpetuating challenges associated with declining populations in rural areas of Newfoundland and Labrador; meaning that rural students will be further affected by lower socioeconomic status, fewer qualified teachers, and fewer educational resources. If this pattern continues, the rural-urban achievement gap can only widen.

The results of this study suggest that a web-based delivery approach to high school courses (at least in physics and chemistry) is a means of overcoming the challenges associated with declining populations in rural localities. Rather than being perceived as a choice of last resort for students in rural schools when subject specific numbers make it difficult to offer specialized programs, it suggests that CDLI would be better perceived as the preferred approach in bringing about equitable educational opportunities to rural students. To this end, future decision makers should be supportive of the continued advancement and expansion of the programs offered through the CDLI.

REFERENCES

Archibald, S. (2006). Narrowing in on educational resources that do affect student achievement. *Peabody Journal of Education, 81*(4), 23-42.

Ascher, C., & Fruchter, N. (2001). Teacher quality and student performance in new york city's low-performing schools. *Journal of Education for Students Placed at Risk, 6*(3), 199-214.

Barbour, M. (2007, February 11). Portrait of rural virtual schooling. *Canadian Journal of Educational Administration and Policy*. 1-21.

Barbour, M., & Mulcahy, D. (2006). An inquiry into retention and achievement differences in campus based and web based AP courses. *Rural Educator, 27*(3), 8-12.

Barbour, M., & Reeves, T. (2009). The reality of virtual schools: A review of the literature. *Computers & Education, 52*(2), 402-416.

Battle, J., & Pastrana, A. (2007). The relative importance of race and socioeconomic status among hispanic and white students. *Journal of Behavioral Sciences, 29*(1), 35-49.

Beldarrain, Y. (2006). Distance education trends: Integrating new technologies to foster student interaction and collaboration. *Distance Education, 27*(2), 139-153.

Benner, A., & Mistry, R. (2007). Congruence of mother and teacher educational expectations and low-income youth's academic competence. *Journal of Educational Psychology, 99*(1), 140-153.

Bernard, R., Abrami, P., Lou, Y., Borokhovsk, E., Wade, A., Wozney, L., et al. (2004). How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. *Review of Educational Research, 74*(3), 379-439.

Boone, W. (2008). *The evolution of e-learning in small rural schools in Newfoundland and Labrador.* Retrieved July 2009 from http://www.mun.ca/killick/documents/Evolution_E_Learning_NL.pdf

Bouchey, H., & Harter, S. (2005). Reflected appraisals, academic self-perceptions, and math/science performance during early adolescence. *Journal of Educational Psychology, 97*(4), 673-686.

Brown, J., Sheppard, B. & Stevens, K. (2000). *Effective schooling in a telelearning environment: Centres of innovation in information and communication technologies.* The Centre for TeleLearning and Rural Education, Memorial University of Newfoundland and Labrador.

Cartwright, F. & Allen, M. (2002). *Understanding the urban-rural reading gap.* Retrieved April, 2009 from http://www.statcan.ca/english/research/81-595-MIE/81-595-MIE2002001.pdf

Cavanaugh, C. (1999). *The effectiveness of interactive distance education technologies in k-12 learning: A meta-analysis.* (ERIC Document Reproduction Service No. ED 430 547).

Cavanaugh, C., Gillan, K., Kromrey, J., Hess, M., & Blomeyer, R. (2004). *The effects of distance education on k-12 student outcomes: A meta-analysis.* Learning Point Associates / North Central Regional Educational Laboratory (NCREL)

Centre for Distance Learning and Innovation (2009). *The Centre-overview.* Retrieved August, 2009 from http://www.cdli.ca/.

Chiu, M., & Khoo, L. (2005). Effects of resources, inequality, and privilege bias on achievement: country, school, and student level analyses. *American Educational Research Journal, 42*(4), 575-603.

Condron, D., & Roscigno, V. (2003). Disparities within: Unequal spending and achievement in an urban school district. *Sociology of Education, 76*(1), 18-36.

Cooper, R. (1999). Urban school reform: Student responses to detracking in a racially mixed high school. *Journal of Education for Students Placed At-Risk, 4*(3), 259-275.

Cooper, R. (2000). Urban school reforms from a student of color perspective. *Urban Education. 4*(2), 302-345.

Crocker, R (2007). *Distance learning: Access and outcomes*. Retrieved July 2009 from http://www.mun.ca/killick/ documents/ TrendsReport_Draft2.pdf

Crocker, R., & Riggs, F. (1979). *Improving the quality of education: Challenge and opportunity*. St. John's, NL: Queen's Printing for Newfoundland and Labrador.

Davis B., Sumara, D. & Luce-Kapler, R. (2000). *Engaging minds: Learning and teaching in a complex world.* Mahweh, N.J. Lawrence Erlbaum Associates.

Dewey, J. (2004). My pedagogic creed. In D. J. Flinders & S. J. Thornton (Eds), *The curriculum studies reader* (pp. 17-23). New York and London. RoutledgeFalmer.

Dibbon, D. & Sheppard, B. (2001). *Teacher demand, supply and retention in Newfoundland and Labrador*. St. John's, NL: Memorial University.

Dufour, R. (2004). What is a "professional learning community"? *Educational Leadership, 61*(8), 6-11.

Eastern School District of Newfoundland and Labrador (2009). *2008-2009 Transportation Information*. Retrieved July 8, 2009 from http://www.esdnl.ca/schools/busroutes/ western_region.pdf

Ender, P. (2003). *Introduction to research design and statistics: Effect size*. Retrieved July 8, 2009 from http://www.gseis.ucla.edu/courses/ed230a2/notes/effect.html

Fan, X., & Chen, M. (1999). Academic achievement of rural school students: A multi-year comparison with their peers in suburban and urban schools. *Journal of Research in Rural Education, 15*(1), pp.31-46.

Fetler, M. (1999). High school staff characteristics and mathematics test results. *Education Policy Analysis Archives, 7*(9).

Graham, S., Taylor, A., & Hudley, C. (1998). Exploring achievement values among ethnic minority early adolescents. *Journal of Educational Psychology, 90*(4), 606-620.

Greene, B., Miller, R., Crowson, H., Duke, B., & Akey, K. (2004). Predicting high school students' cognitive engagement and achievement: Contributions of classroom perceptions and motivation. *Contemporary Educational Psychology, 29*(4), 462-482.

Greenwald, R., Hedges, L.., and Laine, R.. (1996). The effect of school resources on student achievement. *Review of Educational Research, 66*(3), 361-396.

Hannum, W., Irvin, M., Lei, P., & Farmer, T. (2008). Effectiveness of using learner-centered principles on student retention in distance education courses in rural schools. *Distance Education, 29*(3), 211-229.

Hobbs, V. (2004). The promise and the power of distance learning in rural education. *Policy Brief. Rural School and Community Trust.* 1-36

House, J. (2004). Cognitive-motivational characteristics and science achievement of adolescent students: Results from the TIMSS 1995 and TIMSS 1999 assessments. *International Journal of Instructional Media, 31*(4), 411-425.

Hoy, W., Tarter, J., & Hoy, A. (2006). Academic optimism of schools: A force for student achievement. *American Educational Research Journal, 43*(3), 425-446.

Huang, G., & Howley, C. (1993). Mitigating disadvantage: Effects of small-scale schooling on student achievement in Alaska. *Journal of Research in Rural Education, 9*(3), 137-149.

Khattri, N., Riley, K., & Kane, M. (1997). Students at risk in poor, rural areas: A review of the research. *Journal of Research in Rural Education, 13*(2), 79-100.

Konstantopoulos, S. (2006). Trends of school effects on student achievement: Evidence from NLS:72, HSB:82, and NELS:92. *Teachers College Record, 108*(12), 2550-2581.

Krashen, S. (2005). The hard work hypothesis: Is doing your homework enough to overcome the effects of poverty? *Multicultural Education, 12*(4), 16-19.

Lee, J., & McIntire, W. (1999). *Understanding rural student achievement: Identifying instructional and organizational differences between rural and nonrural schools.* Paper presented at the Annual Meeting of the American Educational Research Association, Montreal, Canada. (ERIC Document Reproduction Service No. ED 430 755).

Lee, J., & McIntire, W. (2000). Interstate variation in the mathematics achievement of rural and nonrural students. *Journal of Research in Rural Education, 16*(3), 168-181.

Newfoundland and Labrador, Department of Education (2002). *School changes (Effective Sept. 2002).* Retrieved August 20, 2008 from http://www.education.gov.nl.ca/sch_rep/2002/sch_chng.htm

Newfoundland and Labrador, Department of Education (2003). *School changes 2003-04.* Retrieved August 20, 2008 from http://www.education.gov.nl.ca/sch_rep/2003/sch_chng.htm

Newfoundland and Labrador, Department of Education (2004). *School changes 2004-05.* Retrieved August 20, 2008 from http://www.education.gov.nl.ca/sch_rep/2004/sch_chng.htm

Newfoundland and Labrador, Department of Education (2008). *Education statistics 2008-2009, elementary-secondary.* Retrieved August 20, 2008 from http://www.ed.gov.nl.ca/edu/ publications/k12/stats/index.html#0809

Newfoundland and Labrador, Department of Human Resources, Labour and Employment (2005). *Reducing poverty in Newfoundland and Labrador*. Government of Newfoundland and Labrador.

Port de Grave Harbour Authority (2005). *Welcome to Port de Grave's Web Presence.* Retrieved July 20, 2008 from http://www.nfld.net/hapdg/.

Raudenbush, S., Fotiu, R., & Cheong, Y. (1998). Inequality of access to educational resources: A national report card for eighth grade math. *Educational Evaluation and Policy Analysis, 20*(4), 253-269.

Raudenbush, S. W., Fotiu, R. P., & Cheong, Y. F. (1999). Synthesizing results from the trial state assessment. *Journal of Educational and Behavioral Statistics, 24*(4), 13-38.

Reeves, E. (2003). Disentangling the effects of nonmetro location and student poverty on school performance/improvement: implications for equitable excellence in kentucky public schools. *Journal of Research in Rural Education, 18*(1), 17-30.

Reeves, E., & Bylund, R. (2005). Are rural schools inferior to urban schools? A multilevel analysis of school accountability trends in Kentucky. *Rural Sociology, 70*(3), 360-368.

Rice, K. (2006). A comprehensive look at distance education in the k-12 context. *Journal of Research on Technology in Education, 38*(4), 425-448.

Riggs, F. (1987). *Report of the small schools study project*. St. John's, NL: Queen's Printing for Newfoundland and Labrador.

Roscigno, V. (1998). Race, institutional linkages, and the reproduction of educational disadvantage. *Social Forces, 76*(3), 1033-1061.

Roscigno, V., & Ainsworth-Darnell, J. (1999). Race, cultural capital, and educational resources: persistent inequalities and achievement returns. *Sociology of Education, 72*(3), 158-178.

Roscigno, V., & Crowley, M. (2001). Rurality, institutional disadvantage, and achievement/attainment. *Rural Sociology,66*(2), 268-292.

Ryan, W. (1996). The effectiveness of traditional vs. audiographics delivery in senior high advanced mathematics courses. *Journal of Distance Education, 11*(2), 45-55.

Schacter, J., & Thum, Y. (2004). Paying for high- and low-quality teaching. *Economics of Education Review, 23*(4), 411-430

Seifert, T.; Sheppard, B.; Vaughn, A.M. (2008). *Examining the effectiveness of distance education: Results from multi-level modeling.* Annual Conference of European Distance and E-Learning Network, Lisbon, Portugal.

Seifert, T., Sheppard, B., Vaughan, A.M. (2009). Examining the effectiveness of distance education: Results from multi-level and multi-level mixture modeling. In U. Bernath, A. Szuce, A. Tait, & M. Vidal (Eds.), *Distance and E-learning in transition* (pp. 141-150). San Francisco: Wiley-ISTE.

Shachar, M. (2008). Meta-Analysis: The preferred method of choice for the assessment of distance learning quality factors. *International Review of Research in Open and Distance Learning, 9*(3), 1-15.

Shen, J., Mansberger, N., & Yang, H. (2004). Teacher quality and students placed at risk: Results from the baccalaureate and beyond longitudinal study, 1993-97. Educating students placed at risk. *Educational Horizons, 82*(3), 226-235.

Sheppard, B. (2008). Intermediate program review student survey background report. In Atlantic Evaluation and Research Consultants, *Review of Intermediate Education in Newfoundland and Labrador*. St. John's, NL.: Atlantic Evaluation and Research Consultants.

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *Journal of Educational Research, 95*(6), 323-32.

Sparkes, L. & Williams, L. (2000) *Report of the ministerial panel on educational delivery in the classroom: Supporting learning*. Government of Newfoundland and Labrador, March 2000.

Tallent-Runnels, M., Thomas, J., Lan, W., Cooper, S., Ahern, T., Shaw, S., et al. (2006). Teaching courses online: A review of the research. *Review of Educational Research, 76*(1), 93-135.

UCLA: Academic Technology Services, Statistical Consulting Group (n.d). *Repeated measures analysis using SAS.* Retrieved October 2008 from http://www.ats.ucla.edu/ stat/sas/seminars/sas_repeatedmeasures/default.htm

Ungerleider, C. & Burns, T. (2003). *A systematic review of the effectiveness and efficiency of networked ICT in education.* A report to the Council of Ministers of Education, Canada and Industry Canada.

Unnever, J., Kerckhoff, A., & Robinson, T. (2000). District variations in educational resources and student outcomes. *Economics of Education Review, 19*(3), 245-259.

Voogt, J. & Knezek, G. (2008). IT in primary and secondary education: emerging issues. In J. Voogt & G.Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. xxvii-xlii). New York: Springer.

Warren, P., Curtis, D., Sheppard, B., Hillier, R., & Roberts, B. (2003). *Facing the challenge: a report of the study group on hours of work.* Department of Education, Newfoundland and Labrador. Retrieved July 9, 2009 from http://www.ed.gov.nl.ca/edu/pub/study/report.pdf

Webster, B., & Fisher, D. (2000). Accounting for variation in science and mathematics achievement: A multilevel analysis of Australian data third international mathematics and science study (Timss). *School Effectiveness & School Improvement, 11*(3), 339-360.

Wenglinsky, H. (1998). Finance equalization and within-school equity: The relationship between education spending and the social distribution of achievement. *Educational Evaluation and Policy Analysis, 20*(4), 269-283.

Wenglinsky, H. (2002). the link between teacher classroom practices and student academic performance. *Education Policy Analysis Archives, 10*(12).

White, S., & Reid, J. (2008). Placing teachers? Sustaining rural schooling through place-consciousness in teacher education. *Journal of Research in Rural Education, 23*(7), 1-11.

Williams, J. (2005). Cross-national variations in rural mathematics achievement: A descriptive overview. *Journal of Research in Rural Education, 20*(5), 1-18.

Young, D. (1997, March 1). *A multilevel analysis of science and mathematics achievement*. Paper presented at the Annual Meeting of the American Educational Research Association, Chicago, IL. (ERIC Document Reproduction Service No. ED 410 242).

Young, D. (1998a). Rural and urban differences in student achievement in science and mathematics: A multilevel analysis. *School Effectiveness and School Improvement, 9*(4), 386-418.

Young, D. (1998b, April 1). *Characteristics of effective rural schools: A longitudinal study of Western Australian rural high school students*. Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, CA. (ERIC Document Reproduction Service No. ED 422 151).

Zhao, Y., Lei, J., Yan, B., Lai, C., & Tan, H. (2005, August 1). What makes the difference? A practical analysis of research on the effectiveness of distance education. *Teachers College Record, 107*(8), 1836-1884.

APPENDICES

Appendix A

Commitment of Privacy and Confidentiality

Protection of privacy. The *High School Certification File* contains personal, identifiable information in the form of names, addresses, and MCP numbers. We intend to implement several measures to ensure the protection of personal information.

First, we have asked the agency who made the data available to us to remove as much identifying information as possible prior to providing us with the data. We noted specifically that names and addresses of students would not be part of our data file; however, we noted that MCP numbers were needed to match student information in the High School Certification File with the MUN student records. Specific knowledge regarding MCP numbers and deliberate effort to determine identities could lead to the identification of individuals; however, the commitment of the researchers in this study is that each person authorized to access the data through our research commit to the protection of privacy that has been guaranteed by each of the principal investigators.

Second, once the datasets have been merged to create a working dataset, we have committed that the MCP number will be dropped from the working dataset, eliminating the last vestige of identifying information. The working dataset will be stored on secure University computers with password protection. The original datasets will then be removed from the computer, and the CDs on which they were supplied stored in a secured location, such as a locked file cabinet.

Third, in our request we noted that the three senior researchers that will have access to the data are Drs. Robert Crocker, Tim Seifert, and Bruce Sheppard. Further, we noted that other members of the research team, including graduate students and research assistants, would have controlled access after having signed a **Pledge of Protection of Privacy and Confidentiality.**

Fourth, our reports will contain summary and inferential statistics based upon aggregation of data. No individuals will be identified in published reports.

To ensure confidentiality of individual records and to protect the individuals who have provided this data, other members of the research team who have access to the data will sign a pledge of confidentiality. Since research assistants may be involved with organization of the data to create the working dataset, they may have access to the data files with MCP numbers in the short term. They will be informed of, and expected to adhere to, the ethical obligations of confidentiality.

Pledge of Protection of Privacy and Confidentiality

Having read and understood the above commitments that have been made by the principal investigators regarding protection of privacy and confidentiality, I, the undersigned, agree to adhere to each and every commitment that applies to the senior researchers and that applies uniquely to other members of the research team and/or research assistants.

Signature: ______________________________

Witness: ______________________________

Date: ______________________________

Appendix B

July 12, 2006

Ms. Marion Fushell
Assistant Deputy Minister
Primary, Elementary, and Secondary Branch
Department of Education
P. O. Box 8700
St. John's, Newfoundland
A1B 4J6

Dear Ms. Fushell,
This is a request for access to the High School Certification data for research purposes. As you are aware, the Department of Education is one of the partners in the Community-University Research Alliance (CURA) that has as one of its goals to undertake research projects for the generation of new knowledge about e-learning in the Province of Newfoundland and Labrador.

Although there has been a proliferation of the use of new learning technologies, there has not been extensive research to provide evidence of their effectiveness (Ungerleider & Burns, 2003). Since the Province of Newfoundland and Labrador has a history of commitment to, and implementation of, e-learning technologies, a potential source of information is an examination of the patterns and trends pertaining to topics such as achievement and growth of use. For example, do students who participate in distance education courses achieve at levels comparable to those who do not? Do those who take high school courses by distance education perform as well in University courses as those who do not? What are the characteristics of students who take courses, and how have those characteristics changed over the last ten years?

Our proposal is to make use of the High School Certification databases to ask and answer questions about the effectiveness of e-learning in three domains: access to e-learning, learning outcomes, and cost. It is to that effect that we are seeking your permission to gain access to the above noted data for these purposes. As well, we invite you as one of our essential community partners to collaborate with us in defining other questions that you may wish to include in our research.

In this project, only one ethical issue seems pertinent, that of the protection of privacy. We do note that the Freedom of Information and Protection of Privacy Act does provide for disclosure of identifying information for research purposes if the department head is satisfied that appropriate precautions are in place. However, within the university we also have to adhere to the Tri-Council ethics policies. As stated in the TCPS, secondary use of data becomes a problem of ethics if the possibility exists that the data can be linked to individuals or individuals can be identified in published reports. We have taken several measures to ensure the protection of students' privacy

Protection of privacy. The *High School Certification File* contains personal, identifiable information in the form of names, addresses, and MCP numbers. We intend to implement several measures to ensure the protection of personal information.

First, we would ask that you remove as much identifying information as possible prior to providing us with the data. We do not need, nor are we requesting, the names and addresses of students. However, MCP numbers are needed to match student information in the High School Certification File with the MUN student records. Yet, in-and-of themselves, MCP numbers do not convey the identities of individuals. Consequently, the possibility of identifying a student from the dataset is small. We will need to identify schools but can drop from the data file any school with fewer than five students to reduce the risk that the school identified will lead to identification of students. Unfortunately, we cannot drop courses with fewer than five students in a school since this would eliminate a large proportion of distance education students.

Second, once the datasets have been merged to create a working dataset, the MCP number will be dropped from the working dataset, eliminating the last vestige of individual identifying information. The working dataset will be stored on secure university computers with password protection. The original datasets will then be removed from the computer, and the CDs on which they were supplied stored in a secured location, such as a locked file cabinet.

Third, only three senior researchers, Robert Crocker, Tim Seifert, and Bruce Sheppard will have access to the original data files. Graduate students and other researchers will have access only to non-identifying information. They will not have access to the data files with MCP numbers and they will be informed of, and expected to adhere to, the ethical obligations of confidentiality.

Fourth, our reports will contain summary and inferential statistics based upon aggregation of data. No individuals or schools will be identified in published reports.

These measures will ensure confidentiality of individual records and will serve to protect the individuals who have provided this data.

Thank you in advance for your consideration of this request. We are hopeful that your authorization will be forthcoming at your earliest convenience, and that the research that will be made possible as a result will serve to advance our knowledge related to e-learning and contribute to the evidence that is needed for future planning, decision-making, and policy development in this rapidly emerging field.

Sincerely,

Tim Seifert
Associate Professor

Bruce Sheppard
Associate Professor

Appendix C

Changes to School ID
Based on School Restructuring
Between September, 2002 and June, 2005

Old School			New School		
School Year	School Name	School Id	School Year	School Name	School Id
2002-2003	Goose High School	3	2003-2004	Mealy Mountain	477
2002-2003	Holland's Memorial	81	2003-2004	Gros Morne Academy	86
2002-2003	Holy Cross School, St. Alban's	412	2003-2004	Greenwood Academy, Milltown	407
2002-2003	Coaker Academy	203	2003-2004	New World Island	478
2003-2004	Immaculate Conception	293	2004-2005	St. Michael's High	296

Assumptions and Related Changes Made to School IDs

i. If the school ID was missing for the 2003-2004 school year, but the school ID for the 2002-2003 and 2004-2005 were the same, the missing 2003-2004 school ID was assigned the value equal to the 2002-2003 and 2004-2005 school ID.

ii. If the school ID for the 2002-2003 and the 2003-2004 where missing, they were assigned the same value as the 2004-2005 school ID.

iii. If the school ID was missing for the 2002-2003 school year, but the school ID for the 2003-2004 and 2004-2005 were the same, the missing 2002-2003 school ID was assigned the value equal to the 2003-2004 and 2004-2005 school ID.

iv. If the school ID was missing for the 2002-2003 school year, and the 2003-2004 and 2004-2005 school ID were not equal, the 2002-2003 school ID was assigned the value equal to the 2003-2004 school ID.

v. If the school ID was missing for the 2003-2004 school year, and the 2002-2003 and 2004-2005 school ID were not equal, the 2003-2004 school ID was assigned the value equal to the 2004-2005 school ID.

vi. If the 2002-2003 and the 2004-2005 school ID were 81 and 86, respectively, then the 2003-2004 school ID was assigned the value of 86.

vii. If the 2002-2003, 2003-2004, and 2004-2004 school IDs were 141, 145 and 141, respectively, then the 2002-2003 school ID was assigned the value of 145.

viii. If the 2002-2003, 2003-2004, and 2004-2004 school IDs were 145, 145 and 141, respectively, then the 2003-2004 school ID was assigned the value of 141.

ix. If the 2002-2003 and 2004-2004 school ID were equal, the 2003-2004 school ID was assigned the same value.

x. If the 2004-2005 school ID was 458, it was resigned to 141.

xi. If 2002-2003,2003-2004, and the 2004-2005 school IDs were 3,4, and 477, respectively, then the 2003-2004 school ID was reassigned to 477.

xii. If 2002-2003,2003-2004, and the 2004-2005 school IDs were 3,6, and 477, respectively, then the 2003-2004 school ID was reassigned to 477.

xiii. If 2002-2003,2003-2004, and the 2004-2005 school IDs were 203,203, and 478, respectively, then the 2003-2004 school ID was reassigned to 478.

xiv. If 2002-2003,2003-2004, and the 2004-2005 school IDs were 412,412, and 407, respectively, then the 2003-2004 school ID was reassigned to 407.

xv. Observations were deleted if "PRIVATELY SUPERVISED CANDIDATE" was assigned to any of the school IDs.