Exploring School Building Conditions and School Geographical Location on Student Achievement in Alberta

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Abstract

The purpose of this quantitative non-experimental study was to determine if school geographical location and school building condition affected student academic achievement in Alberta, Canada kindergarten to grade nine schools. A 3 x 3 factorial ANOVA was used to assess the difference in student academic achievement between school building condition, and between school geographical location in the province of Alberta. A Pearson's r correlation was used to define the relationship in the change of school building condition and the change in student academic achievement for modernized or replaced schools between 2003 and 2009. The results of this study concluded that there is no impact of school geographical location or school building condition on student academic achievement. School geographical location had a significant main effect on student academic achievement in 2003 (grade six ρ = .016, nine ρ = .048, school average ρ = .011) and 2006 (grade six ρ = .000, nine ρ = .001, school average ρ = .003), however, statistical significance was not present in 2009. School building condition had a significant main effect on student academic in 2006 (grade three ρ = .034) and 2009 (grade six ρ = .009), however, statistical significance was not present in 2003. No interactive effect existed in the three study periods. No correlation existed between schools modernized or replaced between 2003 and 2009 and changes in student academic achievement, except in grade nine (ρ = .039). Facility planners and education leaders will benefit from the current study by knowing Alberta has somehow mitigated the impact school building condition has on student academic achievement, and it has eliminated the impact of school geographical location.

Studies based in the United States have demonstrated school building condition can significantly affect student academic achievement (Earthman & LeMasters, 2007). However, no such studies have been conducted in Alberta, Canada. It appears no studies have considered the interactive impact school building condition and school geographical location has on student academic achievement. Educational leaders in both the United States and Canada face increased pressure to achieve high results on prescribed criterion-referenced standards-based assessments. In Alberta, the results of provincial assessments are included in the school jurisdiction's annual education results report and are subject to scrutiny through the government accountability framework ("About Provincial Testing," 2008). Factors affecting academic achievement are many and have complex interactions. Little knowledge exists on how school building condition affects student academic achievement within the Canadian educational system.

The general problem under study is that student academic achievement in Northern Alberta is lower than student academic achievement in other geographical locations in the province of Alberta ("About Provincial Testing," 2008; van Tamelen, 2009). The specific problem is that the Government of Alberta has inconsistent planning and funding methods to support its schools' building maintenance and construction programs which could have an impact on student achievement (Schmold, 2010). The purpose of this quantitative correlational study is to determine if student academic achievement is influenced by school geographical location and school building condition in Alberta kindergarten to grade nine (K-9) schools. The

data derived from this study shows the relationship between archival Provincial Achievement Tests (PATs), school building condition, and school geographical location for K-9 schools in the province of Alberta.

Background of the Problem

Researchers have been interested in factors that influence student academic success for more than 75 years (Crampton, 2006). Studies conducted as early as 1980 found positive correlations between school building condition and student achievement (Cash, 1993; LeMasters, 1997). No studies exist that consider the impact of school building condition and student achievement in Alberta, Canada. Research in the United States indicates support for a connection between school building condition and learning (Earthman & LeMasters, 2007; Smith, 2008); however, certain studies have concluded a limited relationship (Crook, 2006; Fuselier, 2008). Indoor air quality, thermal comfort, lighting and day lighting, and acoustics are some factors that have a positive influence on student learning (Buchanan, 2007; Earthman & LeMasters, 2007; Madsen, 2005).

Earthman and LeMasters (2007) posited that physical school building condition contributes directly to students' well-being as well as their academic success. Environmental indoor air quality is a concern in older school buildings and contributes to the raising levels of asthma in school-aged children, which affects attendance and overall school achievement (Buchanan, 2007). Most research studies examining the relationship between student academic success and school building condition focus primarily on schools in the United States. Studies have examined schools in the states of Virginia (Crook, 2006; Hines, 1996; Lanham, 1999), Indiana (Syverson, 2005), Carolinas (Smith, 2008), Pennsylvania (Fuselier, 2008; O'Sullivan, 2006), and Texas (Lair, 2003; O'Neill, 2000).

The structure of the Canadian education system is significantly different from the United States. In Canada, the federal government has no jurisdiction over kindergarten to grade 12 public schooling ("Schools: Government of Alberta," 2009). Vested authority stays at the provincial government level. The provincial government delegates certain responsibilities to the locally elected school boards. The provincial Government of Alberta has taken full responsibility for providing capital and maintenance funding for its public school buildings. Locally elected school boards do not have authority to assess property taxes to fund school capital projects independent of provincial grants. The governmental responsibility includes deciding when to build a new school or modernize an old school, finalization of the school size and course alternatives, and providing funds to build and modernize the school building ("Alberta Education/Alberta," 2009). Each school jurisdiction must submit annual capital plans to advise the provincial government of their local needs. Once submitted to government, the local school jurisdiction has little involvement in controlling the priority of a capital project or if it will receive funding.

Educational leaders in both the United States and Canada face increased pressure to achieve high results on prescribed criterion-referenced standards-based assessments. In Alberta, the results of provincial assessments are included in the school jurisdiction's annual education results report and are subject to scrutiny through the government accountability framework ("About Provincial Testing," 2008). The government accountability framework does not consider either the condition of the school buildings or the geographical location of the schools when evaluating the success of the school jurisdiction. Despite government's commitment to

provide quality education facilities, there exists a backlog of new school buildings sought ("Schools: Government of Alberta," 2009).

The province of Alberta covers a large geographic area ranging from the 49th degree parallel in the South to the 60th degree parallel in the North (see Appendix A). A significant difference exists between the South and North areas of the province for daylight levels, relative humidity, average temperature, and access to various social service programs (health care and child services). The North is sparsely populated and transportation systems are relatively less developed. Factors affecting academic achievement are many and have complex interactions. The current study endeavors to understand to what affect school building condition and school geographic location influence student academic achievement.

The province of Alberta is responsible to provide safe and healthy school buildings. Through a co-governance mandate, the Ministries of Alberta Infrastructure and Alberta Education implement policies and regulations to oversee the capital and property needs of nearly 1,550 provincial funded schools ("Schools: Government of Alberta," 2009). The design and construction of new schools in Alberta is highly regulated at the provincial level. Total school area is established based on the school grade configuration and anticipated student enrollment. The *Design and Construction: Standards and Guidelines for School Facilities* (2007) manual contains stated standards and guidelines that are applicable to all school designs resulting in an equitable distribution of educational facilities across the province.

Purpose of the Study

The purpose of this quantitative correlational study was to determine if student academic achievement is influenced by school geographical location and school building condition in Alberta K-9 schools. The results of the study may provide the provincial government, educational leaders, and facility planners with information about the importance of maintaining buildings, and how the learning environment influences achievement. A quantitative research method is appropriate for the study as it will numerically determine if a relationship exists between the study variables (Yount, 2006). Correlational design is appropriate for the study as it quantifies any relationship between the three study variables, and indicates the statistical strength of any relationship.

Provincial Achievement Tests (PATs) represent the dependent variable, which derives from archival primary data available from Government of Alberta's (1995-2012) website. The dependent variable provides the measure for student academic achievement for the 2003, 2006, and 2009 school years, which was quantified as the percentage of students who obtained a passing grade of 50% or more on the PATs. The independent variable is school building condition as represented by the adjusted facility audit score for the same periods derived from the 2000 school facility audits, and the school geographical locations (South, Central, and North categorization) within the province of Alberta. School geographic location is determined by applying the school Postal Code to the Canada Post location map (see Appendix A).

Research Questions

The problem specific to the study drives the following primary research question.

R1: What is the relationship between school building condition and school geographical location on student achievement in Alberta?
- $H1_0$: There is no relationship of school building condition and school geographical location on student achievement in Alberta.
- $H1_a$: There is a relationship of school building condition and school geographical location on student achievement in Alberta.

Two sub research questions considered both the differences between the groups and the relationship between the variables in the context of the primary research question.

R1.1: What is the difference in student academic achievement between school building condition, and between school geographical location in the province of Alberta?
- $H1.1_0$: Main effect *school building condition* on student academic achievement is not significant.
- $H1.1_a$: Main effect *school building condition* on student academic is significant.
- $H1.2_0$: Main effect *school geographical location* on student academic achievement is not significant.
- $H1.2_a$: Main effect *school geographical location* on student academic achievement is significant.
- $H1.3_0$: Interaction effect of *school building condition* and *school geographical location* on student academic achievement is not present.
- $H1.3_a$: Interaction effect of *school building condition* and *school geographical location* on student academic achievement is present.

R1.2: What is the relationship in the change of school building condition as measured by the facility condition index and the change in student academic achievement for modernized or replaced schools between the 2003 and 2009 school years?
- $H1.2_0$: Relationship as revealed by the Pearson's *r* coefficient is not significant.
- $H1.2_a$: Relationship as revealed by the Pearson's *r* coefficient is significant.

Related Studies

Numerous studies have examined how school building condition affects student academic success at the high school level in various states (Cash, 1993; O'Sullivan, 2006; Smith, 2008; Syverson, 2005). Crook (2006) and Hines (1996) examined high schools in the Commonwealth of Virginia to determine how cosmetic condition, structural condition and general condition influenced student academic success after adjusting for socio-economic status (SES). Bullock (2007) examined the same variables as Crook, but did so by examining middle schools in the Commonwealth of Virginia. O'Neill (2000) studied middle schools in Texas seeking to understand how school building condition affects student achievement, student behavior and attendance, and teacher turnover rates. Fuselier (2008) sought to understand how lighting or daylight, thermal qualities, and acoustics affect boys and girls in Pennsylvania middle schools. Lanham (1999) studied Virginia elementary schools, and Lair (2003) studied an entire school

district in Texas. Al-Enezi (2002) studied 12th-grade high school students in Kuwaiti. LeMasters (1997) performed a systematic analysis of all studies about building condition, student achievement, and student behavior. Few researchers have examined elementary schools (Lanham, 1999).

Eleven of the 13 studies reviewed support the assertion that school building condition influences student achievement (Al-Enezi, 2002; Bullock, 2007; Cash, 1993; Hines, 1996; Lair, 2003; Lanham, 1999; LeMasters, 1997; O'Neill, 2000; O'Sullivan, 2006; Smith, 2008; Syverson, 2005), with others showing a limited relationship (Crook, 2006; Fuselier, 2008). Crook (2006) found a positive relationship in English, and found a positive but not strong relationship in Algebra and Geometry. Fuselier (2008) found a slight relationship to thermal conditions and no relationship to lighting or acoustics.

Study results varied based on the specific research questions posed, which warranted selecting different statistical methods. All studies that incorporated LeMasters' (1997) theoretical model support the assertion structural and cosmetic conditions affect building condition, which in turn affects student achievement (Al-Enezi, 2002; Bullock, 2007; Cash, 1993; O'Sullivan, 2006; Smith, 2008). Cash (1993) found a high relationship for cosmetic condition but no relationship for structural condition, and suggested science scores were higher in better science facilities and building condition related to student behavior. Hines (1996) found a limited relationship between building condition and student behavior.

Methods

The two statistical calculations selected for the study design consider the research questions put forward. Each design selected addressed the primary research question of the study (R1), and addressed the sub research questions separately (R1.1 and R1.2). The findings of R1.1 and R1.2 provided the basis from which to answer the main research question (R1). The independent variables (school building condition and school geographical location) for sub research question R1.1 are presented as categorical data. The 3 x 3 factorial ANOVA used in R1.1 included continuous data for the dependent variable (student academic achievement). Continuous data were used for sub research question R1.2 to increase the analysis *r* scale from the Pearson's *r* correlation.

Subjects

The population for this quantitative study includes all Alberta schools whose students wrote the 2003, 2006, and 2009 PATs, which also underwent a 2000 facility audit. The sample for the study includes K-9 schools that wrote the 2003, 2006, and 2009 PATs, and underwent a facility audit in 2000. Of the approximately 1,550 schools registered in the province of Alberta, 169 K-9 schools meet the study criteria. The maximum total students represented from the school sample is 49,100 ("Schools: Government of Alberta," 2009). Within the sample, 19,800 students reside in South (59 schools), 20,300 in Central Alberta (66 schools), and 9,000 in the North (39 Schools). The average school size is 335 students in the South, 305 in Central Alberta, and 230 in the North, whereas the average school condition from the 2000 facility audit was 420 points in the South, 465 in Central Alberta, and 502 in the North (higher representing poorer condition). Schools selected include public schools, separate schools (minority religious rights), and francophone schools (Canadian Charter rights).

Data Collection

The school business official from each jurisdiction was invited to complete the Facility Quality Index Survey required to quantify each school's building condition for the 2003, 2006, and 2009 cross-sectional periods. The total sample population of Alberta K-9 schools is 169, of which 91% (153) were approved to participate in the study. Two school jurisdictions out of 42 (5%) failed to return a signed Letter of Collaboration.

A confidence interval is an approach to make statistical decisions by setting "intervals around the population mean, bordered by confidence limits" (Yount, 2006, p. 194). The application of confidence intervals allows conclusions to be made, at a stated level of confidence, if the null hypothesis is true or false. The 3 x 3 factorial ANOVA and related Fisher-Protected Least Significant Difference (FLSD) *post hoc* tests determines if the H_o null hypothesis for R1.1 is valid at the 95% confidence level ($\rho = 0.05$). The Pearson's *r* Coefficient for R1.2 is also valid at the 95% confidence level. Based on a confidence level of 95%, a confidence interval of five, and a maximum sample of 153, the minimum sample size needed to conduct the study is 110 schools.

Data Processing

The design of this correlational study is non-experimental. The collection of PATs, 2000 school facility audit scores, and school geographical location data from government websites, combined with the Facility Quality Index Survey results, allowed the application of statistical techniques to consider the study problem and research questions.

Instrumentation

The survey instrument used in the study to determine school building condition was created from the School Facility Evaluation Project (SFEP) instrument used by architects and engineers to determine the 2000 facility audit scores ("School facility evaluation," 2000). The seven primary areas within the SFEP are "site condition, building exterior, building interior, mechanical systems, electrical systems, portable buildings, and space adequacy" ("School facility evaluation," 2000, p. 4). Survey responses allowed a numeric determination of the facility condition index for the 2003, 2006, and 2009 study years. Variation between schools categorized as good, fair, and poor are a result of the application of the seven primary sections contained in the SFEP. Schools ranked on the extremes of good and poor would have favorable or unfavorable results in all seven sections; however, schools rated from the extremes would have multiple variations within the seven primary sections. This study did not consider the separate impact the seven primary sections have on student academic achievement.

Previous studies have quantified school condition by applying the Commonwealth Assessment of Physical Environment (CAPE), or a modified version thereof (Bullock, 2007; Cash, 1993; Fuselier, 2008; Hines, 1996; Lanham, 1999; Smith, 2008; Syverson, 2005). The CAPE instrument is a survey issued to the school principal, which uses a Likert-type questionnaire resulting in a general building condition index. The response aggregation of 33 questions presented to school principals determined the building condition index. CAPE survey questions examine overall building and classroom condition. Concern was expressed in other

related studies as to the knowledge of the person completing the survey and bias that may be injected into the survey responses.

The SFEP school audit process relied on professional architects and engineers to assess component and general school building condition ("School facility evaluation," 2000). The professional assessment provides a highly reliable baseline to construct a facility condition index. Surveying the school business official rather than the school principal increased the response reliability. School business officials have a close working relationship with project architects and engineers, which facilitates a more informed response to the Facility Quality Index Survey.

The study is not conducted by a professional architect or engineer, and as a result must rely on the SFEP instrument to create valid results. The computation of the facility condition index is a mathematical exercise by applying the Facility Quality Index Survey results received to the year 2000 SFEP results. No professional judgment is required to quantify the 2003, 2006, and 2009 facility condition index. The development of the Facility Quality Index Survey based on an established Alberta school audit process created a common understanding of the results and created valid results consistent with the 2000 SFEP.

Data Analysis

Data pertaining to the study was processed in SPSS® (originally Statistical Package for the Social Sciences) to be analyzed through a factorial ANOVA test using a Fisher-Protected Least Significant Difference (FLSD) multiple comparison process, and Pearson's *r* correlation. A 3 x 3 factorial ANOVA was applied to research question R1.1 and Pearson's *r* correlation to research question R1.2. The results of research question R1.1 and R1.2 were applied to assess the primary research question (R1) to determine the impact school building condition and school geographical location has on student achievement in Alberta. See Table 1 – *Summary of statistical tests*.

Table 1

Summary of Statistical Tests

Research Question	Statistical Test	Data Type
R1.1 – Difference between Groups	3 x 3 factorial ANOVA	Categorical
R1.2 – Relationship between Variables	Pearson's *r* coefficient	Continuous

Primary data for the dependent variable (student academic achievement) was downloaded from the Government of Alberta (1995-2012) website in Excel format for each of the three years, and then copied electronically into SPSS. Categorical data were entered into SPSS depending on the location of the school (see Table 2). School building condition was determined by applying the results of the Facility Quality Index Survey to the year 2000-facility audit results. The number derived from this calculation was entered into SPSS for each of the three cross-sectional years. School building condition was categorized for R1.1 as good, fair, or poor, and as continuous data for R1.2. Data received from the Facility Quality Index Survey was entered into

Excel to determine mathematically the facility condition index for the 2003, 2006, and 2009 school years. See Table 3 – *Descriptive statistics – facility audit scores*. The data entry and results were reviewed by a professional architect to ensure validity.

Table 2

Independent Variables – Categorical Summary

Scale	School Building Condition	Geographical Location
Category 1	Good – Lowest Third	South
Category 2	Fair – Middle Third	Central
Category 3	Poor – Highest Third	North

Professional architects were engaged to complete the Facility Quality Index Survey for a sample of schools that underwent a modernization or replacement project since the 2000 facility audits. A Pearson's *r* correlation compared the survey results received from the school business officials and the professional architects. Obtaining input from professional architects prior to releasing the Facility Quality Index Survey and engaging them in an interrater reliability process subsequent to receiving the survey results determined the level of validity. The interrater reliability comparison indicated a high correlation coefficient between the surveys received from school business officials and the professional architects (N = 14, Sig. (2-tailed) = .000, r = .817, ρ = .01), which supports the assertion that the Facility Quality Index Survey is both valid and reliable (see Table 3).

Table 3

Descriptive statistics – facility audit scores

	Results			
Measure	2000	2003	2006	2009
Minimum	40	26	26	26
Maximum	1,300	1,120	1,120	1,120
N	153	153	153	153

(continued)

Measure	Results			
	2000	2003	2006	2009
Sample – Location				
South		46	45	50
Central		49	51	51
North		28	29	28
Sample – Building Condition				
Good		46	43	46
Fair		35	41	44
Poor		42	41	39
Mean	456.60	407.22	386.78	359.31
Standard Deviation	250.697	229.430	215.178	213.567
Skewness	.857	.683	.567	.680
Kurtosis	.575	.339	.182	.309

Statistical Analysis

Difference between the group. The dependent variable is student academic achievement, which is quantitative ratio data. The independent variables are school building condition and geographical location (categorical nominal data). The 3 x 3 factorial ANOVA test required three separate SPSS univariate calculations for each year with the associated FLSD *post hoc* multiple comparison process tests. The 3 x 3 factorial ANOVA test and related FLSD *post hoc* tests determined if the H_o null hypothesis for R1.1 is valid at the 95% confidence level ($\rho = .05$).

Relationships between the variables. Pearson's *r* correlation determined if a relationship exists between the change in school building condition and the change in student academic achievement for modernized or replaced schools between the 2003 and 2009 school years. Facility condition index (continuous data) and associated PATs were used to increase the analysis *r* scale. SPSS was used to analyze any potential relationship between the variables to assess if a statistical relationship exists between the sample means, adjusting for sample size.

Test of normality. Parametric statistical tests, such as the 3x3 factorial ANOVA and Pearson's *r* correlation deployed in this study require a normal distribution of data, quantitative data, random selection, and similar sample size (Ramsey & Schafer, 2008). Table 4 displays

sample means and standard deviations from the 2003, 2006, and 2009 years for student academic achievement. Normality is not critical given the robustness of *t*-tests, *F*-tests and confidence intervals (Ramsey & Schafer, 2008). The standard deviations for the samples from the 2003, 2006, and 2009 study periods are reasonably similar to accept the use of the two parametric tests deployed in the study. Each independent variable is independent of the other.

Table 4

Means and Standard Deviations – Student Academic Achievement Data

Variable	2003 Data		2006 Data		2009 Data	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
School Geographic Location						
Grade 3						
South	88.065	9.4624	84.180	10.5721	79.764	16.7901
Central	87.051	13.1153	85.214	13.0223	79.908	16.0969
North	81.918	15.8239	84.083	13.3818	82.293	13.4910
Grade 6						
South	85.393	10.8700	85.360	8.5474	81.068	11.4782
Central	84.439	12.2455	79.033	16.6339	79.984	15.7102
North	77.536	12.9870	72.407	14.4914	78.575	17.7850
Grade 9						
South	80.280	13.5586	81.651	13.1193	78.290	13.6742
Central	77.082	15.2102	74.976	15.4027	75.698	15.2742
North	71.139	15.3762	68.593	14.5524	70.793	17.6415
School Average						
South	84.570	8.9434	83.713	8.2161	79.704	10.9310
Central	82.845	11.3716	79.772	12.8833	78.529	13.5662
North	76.857	11.1669	75.024	10.7549	77.221	12.6926
School Building Condition						
Grade 3						
Good	86.693	11.7853	88.063	9.8794	80.889	19.0548
Fair	85.709	14.5406	81.198	11.9585	81.384	13.3720
Poor	86.250	12.3929	84.307	13.8135	78.613	14.1516

(continued)

Variable	2003 Data		2006 Data		2009 Data	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Grade 6						
Good	84.078	9.9269	79.495	13.4652	81.783	12.8936
Fair	82.703	12.6953	79.963	13.7056	8/2.598	11.2610
Poor	82.724	14.2243	79.876	16.4324	75.292	18.6442
Grade 9						
Good	75.237	13.7791	73.565	14.0680	74.200	16.9712
Fair	76.257	17.2075	76.973	15.4200	77155	11.3484
Poor	79.331	14.1562	77.271	16.0181	75.623	17.4298
School Average						
Good	81.993	9.4834	80.356	10.7860	78.959	13.1625
Fair	81.549	12.3766	79.361	10.7490	80.373	10.3070
Poor	82.755	11.0059	80.476	12.5609	76.510	13.4186

Results

Collection of Data

The study sample included all 169 K-9 schools in the province of Alberta. Not all school jurisdictions provided Letters of Collaboration to participate in the study, resulting in a final sample of 153 K-9 schools (90.5%). The total number of surveys returned for this quantitative correlational study was 153, which represented a 100% response rate. The surveys allowed for the quantification of school building condition for the 2003, 2006, and 2009 study years. Survey samples received exceeded the minimum sample size of 110 schools.

Assumptions, Limitations and Delimitations

Four assumptions were identified in the current study. The first assumption was that the SFEP would provide a sufficient base to construct the facility condition index. The second assumption was the SFEP would provide a similar confidence level to the CAPE assessment instrument. Third, it was assumed that responders to the Facility Quality Index Survey would commit the required time and have sufficient competence to accurately complete the survey instrument. Finally, it was assumed the Facility Quality Index Survey would provide reliable and meaningful data to access school building condition for the 2003, 2006, and 2009 years.

Limitations of this study included any bias that survey responders may inject into the survey results, the inability to identify all variables affecting student achievement, the ability to generalize study findings, and the potential for a low response rate to the survey. A delimitation of the current study is confining the survey to Alberta school

jurisdictions that have K-9 schools that took part in the 2003, 2006, and 2009 PATs and underwent a 2000 facility audit. The limitations of the current study remain valid; however, it is believed high levels of internal and external validity exist.

Research Question R1.1

2003 data. The results of the *Tests of between-subjects effects – 2003 data* indicated school geographical location had a significant main effect in grade six, $F(2,122) = 4.266$, $\rho = .016$, grade nine, $F(2,122) = 3.128$, $\rho = .048$; and school average, $F(2,122) = 4.691$, $\rho = .011$. School geographical location in grade three, school building condition in all grades, and the interactive effect of school building condition and school geographical location do not have a significant effect on student academic achievement ($\rho > .05$). The corrected model, which indicates the predictive effects of all the variables together, is not significant in all grades and school average.

The *FLSD post hoc tests – school geographic location 2003 data* indicates which means have significant variance. For the school average and grade six students, academic achievement means were significantly varied between schools in the South-North and Central-North. In grades three and nine, means were significantly varied between the South-North. There is no significant variance in the means between the South-Central schools.

2006 data. The results of the *Tests of between-subjects effects – 2006 data* indicate school geographical location had a significant main effect in grade six, $F(2,124) = 8.207$, $\rho = .000$, grade nine, $F(2,124) = 7.232$, $\rho = .001$; and school average, $F(2,124) = 6.085$, $\rho = .003$. School building condition had a significant main effect in grade three, $F(2,124) = 3.487$, $\rho = .034$. School geographical location in grade three, school building condition in grades six, nine, and school average, and the interactive effect of school building condition and school geographical location do not have a significant effect on student academic achievement ($\rho > .05$). The corrected model is significant in grades six ($\rho = .026$) and nine ($\rho = .021$), but not significant in grade three and for school average.

The *FLSD post hoc tests – school geographic location – 2006 data* and *FLSD post hoc tests – school building condition – 2006 data* indicated which means had significant variance. For school geographical location, the schools average student academic achievement means were significantly varied between schools in the South-North. No significant variance existed for grade three. In grade six means were significantly varied in all three potential combinations – South-Central, South-North, and Central-North. In grade nine, means were significantly varied between the South-Central and the South-North. School building condition means were significantly varied in grade three for schools in Good-Fair condition.

2009 data. The results of the *Tests of between-subjects effects – 2009 data* indicated school building condition had a significant main effect in grade six, $F(2,128) = 4.960$, $\rho = .009$. School building condition in grade three, nine, and school average, school geographical location in all grades, and the interactive effect of school building condition and school geographical location did not have a significant effect on student

academic achievement ($\rho > .05$). The corrected model is not significant in all grades and school average.

The *FLSD post hoc tests – school building condition – 2009 data* indicated which means had significant variance. The means were significantly varied in grade six between the schools in Good-Poor and Fair-Poor condition. No other significant variance in the means exists for school building condition or school geographical location.

Research Question R1.2

The *Pearson's r correlation – modernized/replaced schools – 2003 to 2009* indicated the correlation coefficient of the change between school building condition and the change in student academic achievement. The Pearson's *r* Correlation indicates there is a significant relationship between the change in school building condition and the change in student academic achievement for schools modernized or replaced from 2003 to 2009 in grade nine ($\rho = .039$). No significant relationship exists in grades three, six, or school average.

Conclusions

The purpose of the current study was to understand how school building condition and school geographical location affect student academic achievement in K-9 schools in the province of Alberta. Data were collected from the 2003, 2006, and 2009 study periods. Research questions R1.1 and R1.2 provided the basis from which to determine if school building condition and school geographical location affects student academic achievement.

Research Question R1.1

Research question R1.1 examined the impact school building condition and school geographical location has on student academic achievement. School building condition was quantified by applying the results of the Facility Quality Index Survey to the 2000 SFEP facility audit scores. School geographical location was quantified by applying the school postal code to the Canada Post postal code map (see Appendix A).

The 3x3 factorial ANOVA results vary depending on the year being studied. The null hypothesis indicated the independent variable effect (school building condition and school geographical location) and interactive effect on student academic achievement is not significant. (See Table 5 – *Research question R1.1 – results summary hypotheses statements*).

Table 5

Research Question R1.1 – Results Summary Hypotheses Statements

Variable	Main effect school building condition on student academic achievement	Main effect school geographical location on student academic achievement	Interactive effect school building condition and school geographical location on student academic achievement
2003 year			
School Average	Null	Significant	Null
Grade 3	Null	Null	Null
Grade 6	Null	Significant	Null
Grade 9	Null	Significant	Null
2006 year			
School Average	Null	Significant	Null
Grade 3	Significant	Null	Null
Grade 6	Null	Significant	Null
Grade 9	Null	Significant	Null
2009 year			
School Average	Null	Null	Null
Grade 3	Null	Null	Null
Grade 6	Significant	Null	Null
Grade 9	Null	Null	Null

Overall assessment. Comparing the results from the three years suggests some observations or trends. In grade three, there is no main effect of school geographical location on student academic achievement. This result is consistent between all three years. Grade six appears to have more frequent variance in the means than other grades and the school average, and grade nine appears to have more significant variance in the means in 2003 and 2006; however, in 2009 grade six had more significant variance.

The gap between student academic achievement for students in the North decreased significantly compared to students in the South or Central locations of the province for the three years (see Table 4). Schools in the North may experience over-heating in the classrooms during the month of May and June because of the lack of air-conditioning provided in the facilities (Earthman & LeMasters, 2007); therefore potentially affecting student academic achievement. The lack of air-conditioning for Northern schools did not change between 2003 and 2009, which does not explain why school geographical location became insignificant in the 2009 study period.

Based on the data analysis, for research question R1.1 the following hypotheses statements are determined to be true:

H1.1$_0$: Main effect *school building condition* on student academic achievement is not significant.

H1.2$_a$: Main effect *school geographical location* on student academic achievement is significant (in 2003 and 2006).

H1.3$_0$: Interaction effect of *school building condition* and *school geographical location* on student academic achievement is not present.

Research Question R1.2

Research question R1.2 examined the correlation coefficient in the change of school building condition as measured by the facility condition index and the change in student academic achievement for modernized or replaced schools between the 2003 and 2009 school years. Table 6 – *Pearson's r correlation – modernized / replaced schools – 2003 to 2009* indicates the correlation coefficient between the change in school building condition and the change in student academic achievement. The correlation coefficient of the change at grades three, six, and school average is not significant. The relationship at grade nine was significant (N = 24, r = .424, ρ = .039). Based on the data analysis, for research question R1.2 the following hypotheses statement is determined to be true:

H1.2$_0$: Relationship as revealed by the Pearson's r coefficient is not significant.

Table 6

Pearson's r Correlation – Modernized/replaced Schools – 2003 to 2009

Variable	Pearson's r Correlation	Sig. (2-tailed)	N
School building condition	1	-	24
School Average	.032	.882	24
Grade 3	-.006	.978	24
Grade 6	-.223	.2958	24
Grade 0	.424*	.039	24

Note: * p < .05

Assessing Primary Research Question R1

The primary research question sought to understand the relationship between school building condition and school geographical location and its impact on student achievement in the province of Alberta. Student academic achievement is the dependent variable, and school building condition and school geographical location are the independent variables. Sub research questions R1.1 and R1.2 provide the basis to assess the primary research question.

The results from research question R1.1 suggest that school geographical location was significant in some grades for the 2003 and 2006 years. However, school geographical location was not significant at any grade for the 2009 year. School building condition was not significant in 2003; however, indicated some significance in 2006 (grade three) and 2009 (grade six). There was no significant interactive effect between school building condition and school geographical location on student academic achievement. Table 5 - *Research question R1.1 – results summary hypotheses statements* summarizes the findings.

The results from research question R1.2 suggest that improvements in school building condition do not correlate with improvements in student academic achievement. Table 6 - *Pearson's r Correlation – modernized/replaced schools – 2003 to 2009* indicates a significant correlation at grade nine ($N = 24$, $r = .424$, $\rho = .039$). However, no significant correlation existed at grade three, grade six, or for school average. Changes in student academic achievement following a school modernization or replacement both increased and decreased separately from improvements in school building condition. Based on the results of research question R1.1 and R1.2 the following hypotheses statement is determined to be true for the primary research question:

$H1_0$: There is no relationship of school building condition and school geographical location on student achievement in Alberta.

Discussion

Alternate Explanation of Results

Several alternate explanations exist that could explain why the current study concluded school building condition does not affect student academic achievement when other studies concluded it does. First, it appears this is the first Canadian-based study to examine the impact school building condition has on student academic achievement. An alternative explanation could be that Canada's universal social programs provided under the *Canada Health Act*, *Canadian Charter of Rights*, and provincial legislation are better meeting the needs posited by Bronfenbrenner's ecological system theory and Maslow's hierarchy of needs (Berk, 2003). Socio-economic status does affect student academic achievement (Caro, 2009) and it is possible the Canadian system of social programming is better meeting the social and emotional needs of disadvantaged students.

The Government of Alberta collects all property and income taxes attributable to education in the province. Education grants are distributed to each jurisdiction through the Renewed Funding Framework, which provides basic education grants as well as differentiated grants to recognized defined unique characteristics ("Funding manual," 2008). SES rates vary greatly across the province of Alberta. Table 7 – *Alberta school socio-economic status data – 2009 school year* summarizes the two incidence rates for the K-9 schools included in the study sample ("Funding manual," 2008; "Statistics Canada," 2008). Based on these data sets, SES appears not to be a factor affecting any geographical differences in student academic achievement.

Table 7

Alberta School Socio-economic Status Data – 2009 School Year

Geographic Location	Statistics Canada – Prevalence of low income before tax in 2005 %, economic families	2009 Alberta Education SES Incident Rate
South	8.605%	0.204
Central	8.343%	0.209
North	6.515%	0.212

Second, previous studies relied upon the school principal to complete the Commonwealth Assessment of Physical Environment (CAPE) survey. Concern was expressed in other related studies as to the knowledge of the person completing the survey and bias that may be injected into the survey responses. The current study used a different instrument to quantify school building condition. The SFEP was originally completed by architects and engineers and the Facility Quality Index Survey was completed by school business officials, which resulted in a 100% return rate to the current study survey. A possible alternate explanation is that both the accuracy and validity of the survey instruments used to quantify school building condition have resulted in divergent study results.

Third, each study has relied on a different criterion-referenced standards-based assessment to quantify student academic achievement. The current and previous studies have identified a potential limitation on using such an assessment to quantify student academic achievement (Bullock, 2007; Hines, 1996; O'Neill, 2000). A possible alternate explanation is different assessment tools resulting in different study outcomes.

Finally, the Organization for Economic Co-operation and Development (OECD) conducts international assessments of 15-year-old students in reading, science, and mathematics. Results are published for the 2003, 2006, and 2009 assessment periods. Canada, as a country, achieves exceptionally high results on the OECD assessment compared to other countries participating in the assessment, while the United States does not perform as well (Knighton, Brochu, & Gluszynski, 2009). The province of Alberta is the highest performing province in Canada on the international assessments in all three assessment areas for each period. A possible alternate explanation is therefore that there is little room for school building condition to affect student academic achievement in Alberta because student achievement is already exceptionally high. This lack of variability room may be mitigating the impacts school building condition has on student academic achievement.

Social Significance of Research

Understanding the impacts school building condition and school geographical location have on student academic achievement provides educational leaders with an

understanding of two variables affecting teaching and learning. Educational leaders in the province of Alberta and other parts of the world could benefit from knowing if school building condition and school geographical location influence student success (Wilson, 2008). The results from the current study provide valuable information to leaders in government and educational organizations to increase the effectiveness of improvement strategies used at various levels.

Summary

The primary research question contained in this study queries if school building condition and school geographical location affect student academic achievement. Two sub research questions provided the basis from which to assess the primary research question. Sub research question R1.1 supported the null hypotheses statements that there was no main effect of school building condition or school geographical location on student academic achievement. There also is no interactive effect of school building condition and school geographical location on student academic achievement. In the 2003 and 2006 years there was a significant effect of school geographical location on student academic achievement; however, no effect was found in the 2009 year. Sub research question R1.2 supported the null hypothesis that there is no correlation between the change in school building condition and the change in student academic achievement for modernized or replaced schools. The conclusion of the primary research question (R1) is that school building condition and school geographical location do not affect student academic achievement.

The results of the current study are different from previously conducted research. Eleven of the 13 previous studies concluded school building condition does affect student academic achievement, while the other two indicated a slight relationship. This appears to be the first Canadian study conducted; the educational and cultural context may be driving different results. Further study into the Canadian education system may highlight reasons why the study resulted in a different conclusion.

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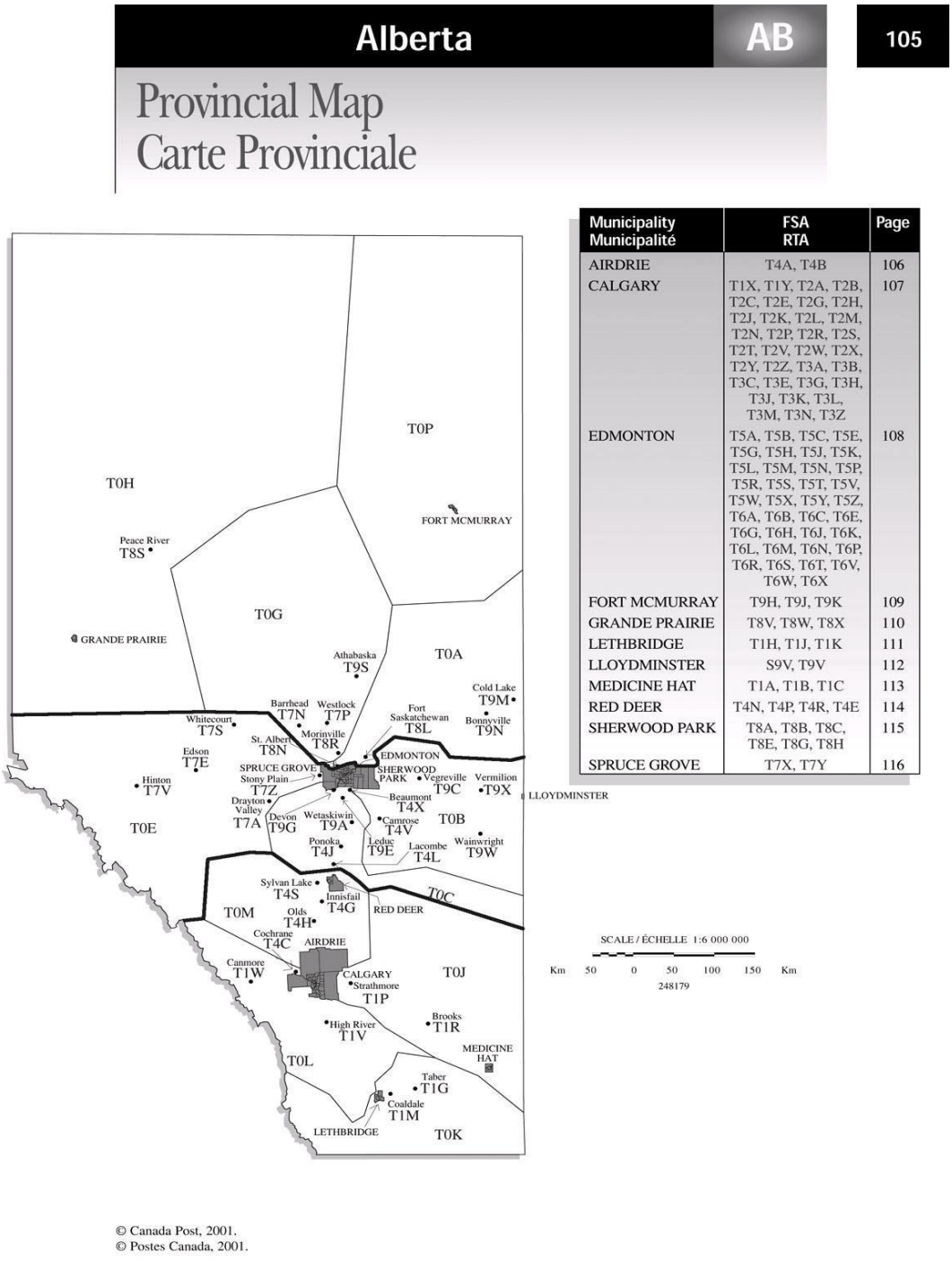
Russell Horswill has 24 years of experience in the Kindergarten to grade 12 public education sector as a school business official. The school business official position is a member of the senior administrative team. Over the length of his career, he has worked in seven school jurisdictions in two provinces (British Columbia and Alberta), and supervises those areas not considered instructional (finance, facility maintenance, transportation, human resources, information technology, capital planning and construction, and Board governance). Russell previously worked in Grande Prairie, Alberta, which is experiencing significant enrollment growth attributed to the oil and gas sector. An aggressive capital expansion program was developed and has been partially implemented. Over his career, Russell has been a strong advocate for clean and healthy schools that support teaching and learning.

Appendix A: Canada Post Postal Code Provincial Map



Municipality Municipalité	FSA RTA	Page
AIRDRIE	T4A, T4B	106
CALGARY	T1X, T1Y, T2A, T2B, T2C, T2E, T2G, T2H, T2J, T2K, T2L, T2M, T2N, T2P, T2R, T2S, T2T, T2V, T2W, T2X, T2Y, T2Z, T3A, T3B, T3C, T3E, T3G, T3H, T3J, T3K, T3L, T3M, T3N, T3Z	107
EDMONTON	T5A, T5B, T5C, T5E, T5G, T5H, T5J, T5K, T5L, T5M, T5N, T5P, T5R, T5S, T5T, T5V, T5W, T5X, T5Y, T5Z, T6A, T6B, T6C, T6E, T6G, T6H, T6J, T6K, T6L, T6M, T6N, T6P, T6R, T6S, T6T, T6V, T6W, T6X	108
FORT MCMURRAY	T9H, T9J, T9K	109
GRANDE PRAIRIE	T8V, T8W, T8X	110
LETHBRIDGE	T1H, T1J, T1K	111
LLOYDMINSTER	S9V, T9V	112
MEDICINE HAT	T1A, T1B, T1C	113
RED DEER	T4N, T4P, T4R, T4E	114
SHERWOOD PARK	T8A, T8B, T8C, T8E, T8G, T8H	115
SPRUCE GROVE	T7X, T7Y	116