DISTANCE DELIVERED EDUCATION AT MONTANA STATE UNIVERSITY - SUPPLEMENTING OR SUPPLANTING CAMPUS REGISTRATIONS: AN EXPLORATION OF CHANGING PATTERNS OVER TIME

by

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Education in Education

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This dissertation has been read by each member of the dissertation committee and has been found to be satisfactory regarding content, English usage, format, citation, bibliographic style, and consistency, and is ready for submission to the Division of Graduate Education.

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December, 2008
DEDICATION

This work is dedicated to Heidi Marie Godwin and Milo Emery Cangiano Godwin as well as my parents, Roger B. Godwin and Brenda C. Godwin who instilled and modeled an appreciation for life-long learning.

“Don’t believe everything you think”

Robert Greenleaf
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The problem addressed in this study was that university system and institutional administrators need to know who (geographically and demographically) the consumers of online courses and programs are. The purpose of this comparative study was to identify student populations and registration patterns over an eight year period in on-campus and online courses offered by Montana State University. Whether or not distinct student populations could be identified based on the mode of course delivery (on-campus vs. online) was established through analysis of spatial and demographic data. The design of this project used a comparative approach to identify differences in population demographics and a spatially sensitive correlational approach to identify associations between the spatial nature of on-campus and online registrations over time. The population included all on-campus and online course registrations offered through MSU from academic year 2000-2001 through 2007-2008.

A Chi Square test was used to provide a spatially unweighted assessment of “spatial” proportionality. The exploratory spatial data analysis tool GeoDa was used to assess the global and local spatial dimension of the research while ANOVAs, factorial ANOVAs, and logistic regression were used to assess the demographic research questions. The Chi Square tests indicated that there are significant differences in the proportion of registrations over time at the local, state and national level. Global spatial autocorrelation tests provide statistically significant, but moderately weak results. The Local Indicator of Spatial Autocorrelation (LISA) analyses point to considerable overlap in registration “footprints” between on-campus and online registrations. Those tests also indicated that changes in spatial patterns have been more evolutionary for online registrations than for on-campus registrations which showed less variation over time. The demographic tests indicated that on-campus and online populations differ both in age and gender composition.

The conclusion based on the results is that online courses are likely supplementing, not supplanting campus registrations at MSU. While the geographic analysis points to significant, fairly extensive, and growing geographic overlap between the home-of-origin locations of online and on-campus populations, the age and gender differences clearly indicate that the online population is older and more female than the on-campus population.
CHAPTER 1
INTRODUCTION TO THE STUDY

Introduction

Distance education is not new. Correspondence courses have been in operation in the United States since the implementation of cheap and reliable mail service in the 1880’s (Moore & Kearsley, 2005; Phipps & Merisotis, 1999). Subsequently, radio and television were used as a delivery medium for distance education as these technologies proliferated throughout the U.S. Population. What is new in distance education is the use of the World Wide Web as the delivery vehicle and personal computers as the human interface at either end. This “Fifth Generation” of distance education came into its own in the 1990’s (Moore & Kearsley, 2005).

What distinguishes this most recent generation of distance education is more than just the technology through which it is delivered and accessed; rather it is the set of combined circumstances that make it attractive for institutions, public and private, to use. The first [of these circumstances] is that there is a clear and easily documented need. Second is that the technology to meet this need is here now and will only improve. And the third reason is that a variety of businesses of various kinds see massive online education as an important emerging market and therefore as a business opportunity. (Harris, 1999, p.87)
While the opportunity exists for computer based distance education to define a new way of teaching and learning (Kirp, 2003; Levine, 2000), in the majority of the cases thus far in it’s short history, this promise has not yet come to pass (Feenberg, 1999; Zemsky & Massy, 2004). Given that many still debate the quality of web-based distance education relative to classroom based instruction (Allen & Seaman, 2003, 2004, 2005; Brown & Kulikowich, 2004; Faux & Black-Hughes, 2000; Washburn, 2001), and rarely conclude that it is better (Tallent-Runnels, Thomas, Lan, Cooper, Ahern, Shaw & Liu, 2006), one might question why the newest generation of distance education has become as important to higher education institutions as it has.

The most concrete and, in some environments, compelling reason for higher education’s interest in distance education revolves around multiple issues associated with revenue (Berg, 2002; Blumenstyk, 2006, October 19; Bocci, Eastman & Swift, 2004; Feenberg, 1999; Harris, 1999; Kriger, 2001; Washburn, 2001). According to Engell and Dangerfield (2005) and Oberg (1998), higher education is fundamentally a huge business. It “is a diverse economic giant, irrespective of what it brings to the greater social whole” (Oberg, 1998, ¶ 9). Oberg (1998) further quantifies the economic impact of higher education in the U.S. as producing $211 billion in annual expenditures. Additionally, the fact that colleges engaged in the online education “business” generated $8.1 billion from tuition in 2006 (Eduventures, 2007) has not been lost on administrators facing static or declining funding from state governments and/or federal agencies (Washburn, 2001).

Another, and usually preferred, justification for engaging in distance education is rooted in the issue of access (Berg, 2002; Cavanaugh, 2005; Kriger, 2001; Levine, 2000;
The more typical issue identified is geographic access (Berg, 2002; Eaton, 2001; Grubesic & Oliver, 2003; Schneider & Germann, 1999) whereby individuals remote to any institution, or a particular institution providing a course or program they need, is accommodated through technological means. However, a second kind of access that has been identified as an issue is temporal access (Berg, 2002; Grubesic & Oliver, 2003; Eaton, 2001; Otte & Benke, 2006; Washburn, 2001). Providing temporal access allows those who may be proximal to an institution but do not have the time to commute, and/or those that lack access due to course scheduling during the work day (Cavanaugh, 2005; Guernsey, 1998), the opportunity to participate in higher education’s offerings.

Grubesic and Oliver (2003) state that despite the claims that distance education can abolish geographic constraints and improve access to potential students, institutions need to know, by evaluating the evidence, whether this is actually the case. They suggest that having an empirically based understanding of potential findings, such as spatial bias due to telecommunication infrastructure or other reasons, is necessary for the development of effective policies and implementation strategies. There is further speculation about the possibility that distance education may have less of an impact on geographic space than it does on temporal availability (Grubesic & Oliver, 2003; Otte, 2007) which would suggest significantly different strategies, policies, and issues for institutions to address.
Palloff and Pratt (2003) indicate that the demographic profile of distance delivered students may be changing. While administrators thus far have emphasized increasing access to non-traditional age student populations, there is some evidence that traditional age students who are already on campus are availing themselves of distance delivered courses (Allen & Seaman, 2006; Blumenstyk, 2006, October 16; Carnevale, 2001; Guernsey, 1998; Pope, 2006; Wallace, 2002). In some cases it may be based on convenience (e.g. a campus based course may conflict with another course, but the distance version can be completed in the evenings). In other cases there may be an actual financial benefit to the student to take a distance delivered course. For instance, a non-resident student at a public institution may find that the pricing structure of distance courses is less expensive than paying non-resident tuition and fees for the same campus based course (Carnevale, 2001). Therefore, it behooves institutions that offer, or plan to offer, distance courses and/or programs to better understand where the “brick” (campus based) and “click” (online) student populations are coming from, what they look like and if those geographic and demographic patterns are static, dynamic, complementary or competitive. Montana State University is just such an institution and a recent consultant’s report (Oaks and Hanna, 2007) of the institutions online efforts identifies the need for the institution to better identify and understand the existing use and populations served in order to better optimize and plan for the future.

Montana State University (MSU) is the principal land grant institution in the state of Montana. Founded in 1893 as the Agricultural College of the State of Montana (Rydell, Safford & Mullen, 1992), MSU enrolled 12,369 students (Montana State
University, 2008) in the 2008 fall semester (up from the 12,170 headcount in fall 2007, the 12,338 headcount in 2006 and 12,250 in 2005). This research oriented institution offers degree programs culminating in baccalaureate through doctoral degrees. The Extended University (EU) is the administrative unit at MSU responsible for continuing education, extended studies and providing the resources and infrastructure for delivering web based instruction through its Burns Technology Center (Extended University, 2006). Some of the online academic courses offered through the Extended University are not considered in-load courses. That is to say, students do not register for them through the Registrar’s Office. Additionally, these courses are offered to students for a flat fee regardless of how a student may be classified for residency. Historically, students who take courses through the EU were not counted in the institutional FTE for state remuneration to the institution. In 2006 the institution began counting all EU students with a Montana home-of-origin address in the FTE for state return. However, the tuition that they pay only passes through the institution’s general fund, where it would otherwise get redistributed through the annual budgeting process, before being rebated to Extended University (K. Obbink, personal communication, August, 2007; J. Rimpau, personal communication, December, 2008). Rather the departments that offer the courses identify the instructors pay rate, then have a negotiated split with the EU for tuition revenue generated above and beyond the instructional costs (R. Carson, personal communication, September 2006).

The Montana Board of Regents, as evidenced by the content of their 2006-2010 Strategic Plan and 2008 Strategic Plan & System Initiatives Update, has indicated that
Montana’s public higher education institutions should be expanding their distance delivered course and program offerings. Goal number one of the plan is to increase enrollment of traditional and non-traditional students as well as improve distance and online learning in the Montana University System (Montana Board of Regents, 2006). However, B. R. McLeod (personal communication, October, 2000), past Dean of the MSU College of Graduate Studies, and others at MSU (Montana State University, 2002) speculated that enrollment in MSU distance delivered courses, approximately half of which are made available through Extended University, may be displacing campus based registrations. Depending on an institution’s pricing structures and internal allocation methodologies, it may be advantageous for academic departments to offer courses through a continuing education or extended studies unit because the tuition distribution includes direct allocation back to the department offering the course rather than the funds going into the University general fund for allocation by the University Planning, Budget and Analysis Committee.

Given the model used for state funding of the institution, a consequence of such displacement would be a decrease in tuition and state support dollars available to the central administration for redistribution with a concurrent increase in the revenue available to individual departments. While this is a good thing for departments and can encourage entrepreneurial efforts, it may not fit in with institutional goals and objectives as it potentially reduces the funds available to the provost to support unique and/or cornerstone programs that may otherwise be unable to attract the student numbers or extramural funding necessary for sustainability.
Problem

The problem addressed in this study was that university system and institutional administrators need to know who (geographically and demographically) the consumers of online courses and programs are.

Purpose

The purpose of this comparative study was to compare student registrations over an eight year period in on-campus and online courses offered through Montana State University. Demographic and geographic data will provide administrators with the information required to identify variability in registration patterns (on-campus vs. online) and whether distinct student populations can be identified based on the mode of course delivery.

Significance of the Study

The results of this study may inform administrators about possible patterns occurring in a portion of their student body not traditionally studied by their institutional research functions principally because they are distant to the institution, thus more difficult to investigate. Having knowledge regarding the geography of registration patterns may assist administrators in determining whether internal structures and/or policies effectively support the best interests of the students and the institution. Additionally, Montana institutions that make an effort to better understand the kinds of students that are being attracted to on-campus and online courses will be better prepared to address the Montana Board of Regents 2006-2010 Strategic Plan.
Research Questions

The following research questions were addressed in this study: 1) Are there different home-of-origin geographic patterns between students taking courses on-campus at MSU and those taking online courses from MSU, 2) How do the home-of-origin geographic patterns between the two groups compare and contrast over the eight year period, from 2000-2001 to 2007-2008, and 3) Is there a significant difference in the basic demographic characteristics (age and gender) of students registering for on-campus and online courses over time? In regards to the demographics, the question can more specifically be broken down into: 3.a. Are there significant differences in the mean ages of the on-campus and online student registrations, 3.b. Have there been significant changes in the mean ages of the on-campus and online student registrations over the specified time period, 3.c. Are there significant differences between the proportions of on-campus and online male and female registrations for each year group, and finally, 3.d. How much of the changes, if there are any, in the proportions of male to female registrations can be attributed to the year group and method of delivery over the eight year time period.

Literature Review & Theoretical Framework

In a resource rich environment there is little incentive to make changes. In a resource rich environment higher education institutions would continue to focus their interest and efforts on the traditional delivery of campus based courses and programs. Institutions in this country, particularly, but not exclusively, public institutions, are not
living in a resource rich environment (Goenner & Pauls, 2006). As has been noted extensively in the literature, resources in higher education have been growing increasingly scarce (Black, 2003; Heck, Johnsrud & Rosser, 2000; Kerr, 1998; Kirp, 2003; Layzell, 1999; Mortenson, 2001; Nerad & Miller, 1996; Rupert, 1997).

One of the results of this increasing pressure has been for institutions to explore opportunities offering the potential for greater “profit margins” (Kirp, 2003; Palloff & Pratt, 2003; Washburn, 2001). Many institutions have launched major efforts to develop distance delivered courses and programs based on the premise that they can capture a new “market” to supplement their campus based enrollment (Dibiase, 2000; Lewis, Snow, Farris, Levin & Greene, 1999; Schiffman et al., 2007). This investment also allows colleges and universities to provide higher education to potential students that want, if not need, it but would otherwise be unable to participate (Eaton, 1999; Hall, 1995).

Underlying the concept of distance education is the definition and/or redefinition of the concept of space. Traditional, or brick-and-mortar, higher education institutions are fixed in space. They have a defined location. Further, institutions are often defined by the geographic extent that they recruit and enroll from (i.e. local, regional, national, and international intuitions) (Mortenson, 2001). Accordingly, the policies and procedures defined by public higher education institutions typically differentiate students based on their residence (typically state or nation) of origin. Students at public institutions who are considered residents of the state generally pay lower tuition than out-of-state (non-resident) or international students. The idea is that a portion of the tuition costs for “in-
state” or resident students has already been paid through state taxes. In many cases, non-resident students are charged a tuition rate that exceeds the cost of the education or subsidizes the resident students (Mixon & Hsing, 1994; Rizzo & Ehrenberg, 2003).

According to Montana Board of Regents (BOR) policy 940.1, “All applicants for admission and students at the campuses of the Montana University System shall be classified as in-state or out-of-state for fee purposes, admission to the campuses, and admission to programs of limited enrollment. A student who is not classified as in-state is considered to be out-of-state.” Because students must be classified as either in-state or out-of state (and pay the associated tuition rates) for campus-based courses, a significant financial disincentive exists for out-of-state students who might otherwise be interested in taking any distance delivered course offered through the Registrar. However, the Policy Statement on Tuition, BOR Policy 940.31, which states that “The issue of competitiveness is especially crucial in setting tuition levels for courses where access to the course is independent of a student's location (e.g., on-line courses)”, allows units to fix the tuition rate of distance delivered courses outside the normal bounds of the BOR residency policy. To date, this has not yet occurred at MSU except when courses are offered through Extended University.

One of the driving assertions of the proponents of web based distance education is that it eliminates the geographic constraints of institutions (Levine, 2000; Washburn, 2001). Theoretically, any institution now has the potential to deliver their courses and programs “any place, any time”. Closer to reality is the realization that absolute, and perhaps even perceived, geographic constraints still exist which influence potential
students ability to participate in distance delivered educational opportunities (Garrett, 2007). Recent research indicates that successful implementation of distance programs requires significant shifts in institutional cultures in order to serve the new clientele to their level of expectation (Berg, 2002; Moore & Kearsley, 2005). While higher education has been quick to embrace the possibilities and respond to the financial and pedagogical allure of online education, the policies and procedures (such as residency based variations in tuition and fees as well as the kinds and delivery of student services required) underpinning the operation of the higher education business have been exceptionally slow to respond (Guernsey, 1998; Miller & Schiffman, 2006; Oaks and Hanna, 2007; Wallace, 1996).

A potential issue associated with institutions jumping into the distance education arena too hastily is that their efforts may cost them more than they recoup (Mangan, 2001; Washburn, 2001). The volume of conflicting assertions regarding the costs associated with the development and delivery of distance courses indicates that those costs are either hard to disaggregate and quantify or vary significantly from institution to institution based on size, administrative structure, regulatory policies, faculty composition, preexisting technology investments and several other factors (Finkelstein & Scholz, 2000).

Beyond changes in infrastructure and staff support, faculty time and effort must also be considered. Few faculty are willing to devote the time and effort necessary to create a distance course without adequate compensation. Beyond development, the question becomes, “Who will teach it?” If a tenure or tenure track faculty will teach it,
will they get a campus course load reduction or receive additional compensation? If an adjunct teaches it, it will still be an additional cost to the instructional budget. If the bulk of the distance courses are then taught by lower paid adjuncts the program becomes open to criticism that the institution is delivering a separate and inferior “product” purely for profit oriented motives.

A bottom line with decisions to develop distance delivered education opportunities seems to be closely tied to the bottom line of an institution’s budget sheets (Berg, 2002; Blumenstyk, 2005; Blumenstyk, 2006; Feenberg, 1999). Certainly it is not the only reason higher education institutions are choosing to engage in distance education opportunities, but from the administrative perspective, few would be willing to extend their institution into an arena where they were knowingly going to operate at a loss (Hebel, 2001; Hecht, Higgerson, Gmelch & Tucker, 1999; Kirp, 2003; Vandament, 1989).

Research Design

Anselin’s (2005) exploratory spatial data analysis tool, GeoDa, is used to generate geographic visualizations (geovisualizations) of spatial variability, explore spatial autocorrelation at the local and global scales, and examine spatial regression. Geovisualizations are visual geospatial displays used to explore data, generate hypotheses, develop problem solutions, and construct knowledge (Buckley, Gahegan & Clarke, 2000; Gahegan, 2000; Kwan, 2007). Using GeoDa and Chi Square statistical tests, this study will explore the geographic patterns of registered on-campus and distance
student’s “home of origin” over an eight year time frame (2000-2001 to 2007-2008). The specified time frame is used because it encompasses the total and complete academic year data available for Extended University served online course registrations. This study provides a distinctive look at the geographic footprint of Montana State University’s educational offerings. Further, it will delineate whether differences exist between the geographic footprint of those students choosing to come to the Bozeman campus to study and those opting to take their MSU education wherever they happen to be.

The Factorial Analysis of Variance (ANOVA), one-way ANOVA, and Logistic Regression were used to examine whether there were significant differences and trend changes in the basic demographics (age and gender) of the campus based students and those taking online courses. When reviewed and compared over the specified time frame, such information should provide insight into the populations being served and whether some of the general suppositions regarding who engages in online education and why apply to the student population(s) being served by MSU. In other words, are there age and gender differences between “brick” and “click” students at MSU, and have the profiles of those populations changed over the eight year study period.

Definitions

Distance education – “The delivery of instruction over a distance to individuals located in one or more venues.” (Lewis et al., 1999, p.1)

Online course – (a) When referenced within the literature review, “A course where most [80+%] or all of the content is delivered online. Typically with no face-to-
face meetings.” (Allen & Seaman, 2005, p. 4); (b) Within the context of the results and data analysis, courses offered at a distance in their entirety with no co-requisite course or other requirement that students participate in course activities on the Bozeman campus.

In-load course – A course offered through the Registrar’s Office. Tuition goes into the university general fund.

Spatial data – Data that can be linked to locations in geographic space and graphically depicted in 2D or 3D representations.

Spatial autocorrelation – The idea that things or populations distributed across a spatial plane exhibit a systematic pattern. In other words, populations/entities are more similar (positive spatial autocorrelation) or dissimilar (negative spatial autocorrelation) to other populations/entities that are close than those that are farther away.

Exploratory spatial data analysis (ESDA) – “A collection of techniques to describe and visualize spatial distributions, identify atypical locations or spatial outliers, discover patterns of spatial association, clusters or hot spots, and suggest spatial regimes or other forms of spatial heterogeneity” (Anselin, Sridharan & Gholston, 2007, p. 290)

Geovisualization (Geographical Visualizations) – Using visual geospatial displays to explore data and through that exploration generate hypotheses, develop problem solutions, and construct knowledge. Geovisualizations maintain the geographic context of the study area while facilitating the recognition and understanding of spatial relationships and patterns in complex data sets (Buckley, Gahegan & Clarke, 2000; Gahegan, 2000; Kwan, 2007).
Home-of-origin – The location identified as the permanent address, or address of origin, of applicants on their initial application to Montana State University.

ZIP code shape file – A digital representation of the space associated with specific ZIP codes and represented by polygons.

Limitations of the Study

A determination was made to use registrations as the unit of study rather than individual students. This was done for two reasons. First, the Full Time Equivalent (FTE), which is a count of total credits registered for during a given semester divided by the number of credits required to meet the qualifications to be designated a “full-time” students, is a fairly commonly used metric in higher education that allows institutions to make enrollment or production comparisons without having to define the number of full-time vs. part-time students. Registrations alone are used as a proxy for FTE students based on the fact that the majority of courses are “standard” three credit courses. The second reason was that the financial picture in higher education is typically based on the number of credits students register for rather than a flat fee per student. Readers need to keep this in mind when reviewing the geographic analysis and be clear that it represents a distribution of the number of courses (credits) registered for, not individuals. In other words a single individual may register for multiple courses or a combination of campus and distance delivered courses.

Another limitation includes the variable quality of the data. In some cases the relevant data, particularly ZIP codes, may be inaccurately reported or transcribed into the
respective databases because they are self-reported (Gliner & Morgan, 2000) or through simple typographical or transcription error. Another issue is the somewhat dynamic nature of ZIP codes as they relate to describing geographic areas. In other words, areas with a single ZIP code can be and are subdivided into multiple ZIP codes as populations within the area swell and spatially differentiate enough to warrant a new postal code (U.S. Census Bureau, n.d.a). In the pilot study for this project, there were occurrences where ZIP codes in the database did not match up with the ZIP code shape file available. In that case, the data from those individuals was discarded.

The final significant limitation involves the paucity of data for many of the ZIP code polygons when doing the analysis at a national scale. Luc Anselin (personal communication, July 21, 2004), the principal developer of the GeoDa ESDA program, indicates that “a lot of zeros…will create problems with the [spatial] statistics”. One alternative, mentioned by J. Koschinsky (personal communication, August 7, 2004), Research Associate for the GeoDa Center, is to regionalize the study to try and eliminate the bulk of the “zero registrations” within ZIP code polygons from the analysis.

**Delimitations of the Study**

The study is being conducted at a large, public, research institution. In accordance with the Carnegie Classification of Institutions of Higher Education, there are no other listed higher education institutions that match Montana State University across all six dimensions of the classification system. Using only the Size & Setting (Large, 4-year and primarily residential) and Basic (Research University with very high research activity)
dimensions, there are 34 other public, 4-year institutions identified as similar. If including private institutions the list grows to 38. If just using the Basic classification dimension, there are 63 similar public institutions and an addition 33 if private institutions are included. Beyond that, the state where the institution is located has one of the lowest population densities in the country (U.S. Census Bureau, n.d.) and in 2005 was ranked 44th in the nation for population, 44th for average per capita income, and 46th for total state spending (Governing, 2005).

Chapter Summary

The purpose of this comparative study was to identify trends and potential differences in the demographic and geographic characteristics of students taking on-campus and online courses at Montana State University. This chapter presented relevant background on the issue, the problem, purpose, and significance of the study, the research questions, an overview of the literature and theoretical framework, an overview of the research design, definitions, limitations and delimitations.

Chapter two of this work will provide a deeper review of the relevant literature in the historical geography of higher education in the U.S.; higher education enrollment, demographics, and institutional choice; finance and distance learning in higher education; geographic location theories and the promise of eliminating spatial constraints; and finally the geography of the internet and the digital divide. Chapter three will more explicitly define the methodology used to execute the objectives of this project. The results, to include geospatial displays (maps) and the summery output from the other
statistical tests conducted will then be presented in chapter four. The final chapter will discuss the findings, place them into context, provide conclusions and recommendations for further research.
CHAPTER 2

LITERATURE REVIEW

Introduction

This chapter will synthesize the literature relevant to this study. Included in this chapter are the general sources from which the literature was gathered, a reiteration of the problem and purpose of the study, a review of the previous pertinent literature, and findings germane to this study. The primary focus of the review is to identify what is known both specifically and peripherally about the subject and what gaps currently exist. Specifically, five categories of information will be reviewed: the historical geography of higher education in the U.S.; higher education enrollment, demographics and institutional choice; higher education finance and distance learning; higher education location theory and the promise of eliminating spatial constraints; and the geography and the internet and the digital divide.

Sources

Sources of the relevant literature reviewed principally include peer reviewed or refereed journal articles, books, and chapters from edited books. Additionally, multiple technical and research reports, both in print and available electronically, have been review and referenced. As much of the ever growing information related to the internet is available exclusively on the internet, many of the sources cited are web based electronic media. Additionally, the exploratory nature of the topic, with associated literature being relatively undeveloped, includes descriptive studies and reports on preliminary
observations. Many of these less rigorously reviewed articles were identified in professional news magazines such as the Chronicle of Higher Education, conference papers, public presentations, and non-refereed journals.

Problem & Purpose of the Study

Based on the review of the literature, the problem addressed in this study was that administrators managing the Montana University System and at Montana State University need to have a better understanding of who (geographically and demographically) the consumers of online courses and programs at MSU are. Anecdotal reports, growing speculation and, in some few cases, empirical research indicate that across higher education, more and more on-campus students are taking advantage of courses being offered by their own institutions via distance delivery. In part to better understand the impacts and implications of existing campus policies and procedures and in part to better, more equitably and more realistically manage the revenue streams, MSU has been wrestling with ways to better define the profile and nature of its students in online courses relative to its on-campus students.

The purpose of this study was to compare students over the past eight academic years registering for courses on-campus through the traditional registrar managed process and those enrolling in credit awarding online courses, often, though not always offered through Extended University, at MSU. The demographic and geographic data will provide state and institution level administrators with the information required to identify patterns in the student profile making possible better data based management and policy decisions.
Review of Previous Literature

The vast majority of the information available regarding distance education falls into three categories: 1) Pedagogical studies supporting or disputing the efficacy of the offerings, 2) Studies focusing on enrollment trends, and 3) the financial impacts of distance education. Whether or not distance education is more, less, or as effective as campus based courses will likely be an unresolved topic of study and pontification for some time to come, but is not an element of interest or concern relative to this study. Studies on recent enrollment trends tend to be descriptive reports such as the almanac published annually by The Chronicle of Higher Education and other reports and publications by such venerable organizations as the National Center for Education Statistics (Lewis et al., 1999; Sikora & Carroll, 2002; Tabs, Waits, Lewis & Greene, 2003) and the Sloan Consortium. And, perhaps indicative of its relative importance among the issues associated with distance education, the quantity and variety of pieces regarding some financial aspect or another of distance education seem to dominate the literature (Berg, 2002; Carnevale, 1999; Carr, 2001; Dahl, 2004; Finkelstein, Frances, Jewitt & Scholz, 2000; Goode, 2004; Lawton & Barnes, 1998; Rothkopf, 2003). This study falls into the broad category of enrollment trends with an emphasis on the comparative spatial distribution of enrollments.

Few explicitly geographic studies have been conducted on higher education (Adams, 2000; Kodrzycki, 1999), let alone the spatial impact of the internet on higher education. Fonseca and Andrews (1993) have used choropleth and surface maps to identify various characteristics of higher education at the state level which can help
identify regional patterns. Various projects have tried to map the internet and Kellerman (2002) has taken that a step further to look broadly at the geography of information. Beyond that, research based geographic explorations of the impact the internet has had on location theory has not been overwhelming. While Bocci, Eastman and Swift (2004) and Anderson, Bowman and Tinto (1972) explored enrollment decisions based on geographic distance from home or work to a campus, Cavanaugh (2005) explored commuting time to campus and Roggeveen and Thompson (1968) took the commuting issue a step further by examining local locational and siteing strategies for higher education institutions, broader explorations of spatial patterns have been few.

As far back as 1921, Kelly presented a report on the distribution of colleges in the United States that attempted to explain the location of colleges and universities based on observational data and estimates of the critical mass of potential students required to develop and maintain a stable institution. Schofer (1975) conceptually linked higher education location decisions to one of the classic location theories, Central Place Theory (Christaller, 1933), and other geographically based gravity models within the context of providing tools for future rational location planning for education administrators. Olivas (2005) purported to look at “Higher Education as ‘Place’”, but focused on the impact of racial distribution on the siteing of campuses. According to T. H. Grubesic (personal communication, August 22, 2006), Associate Professor of Geography at Indiana University, only Grubesic and Oliver (2003) have conducted an empirical spatial analysis attempting to combine the two general themes of geography and higher education by
identifying spatial patterns in the locations of students who register for distance delivered courses.

**Historical Geography of Higher Education in the U.S.**

In order to gain perspective on how internet based distance delivered courses may be impacting the demographic profile and geographic footprint or extent of its student population; we first need to appreciate the historical context of the locating of higher education institutions. The first institution of higher education in the United States, Harvard College, was established in Cambridge, MA, in 1636. While no definitive explanation exists as to why Cambridge was the first location in the United States to host an institution of higher education, there is some evidence that there was enough of a commitment to developing the commonwealth in Boston, founded in 1630, and a general belief that the commonwealth's survival was dependant on leaders trained to serve in the church and state (Herbst, 1982). Thus the institution was born to prepare young men for the ministry (Meiners, 1995; Perkins, 1997; Westmeyer, 1997).

In fact, most of the initial colleges in America were sectarian (Hofstadter & Hardy, 1952; Westmeyer, 1997) and established and/or funded to greater or lesser degrees by the church-states that best described at least nine of the original 13 colonies (Herbst, 1974; Herbst, 1975; Meiners, 1995). To a large degree this limited the number and geographic distribution of these institutions because colonial assemblies were unwilling to grant more than one charter, particularly to competing sects (Meiners, 1995). The result was a dearth of competition among those institutions that were chartered. In an interesting acknowledgement of various geographic location theories, Meiners (1995)
states that with no initial competition in their own areas, “Yale and Harvard did offer one another competition, but high transportation costs limited such efforts” (p. 22).

Looking at the 39 colleges founded before 1800 (Figure 1 - Fonseca & Andrews, 1993), one can see a spatial pattern emerge that is not altogether surprising. The earliest colleges were located along the eastern seacoast with continued establishment further inland as populations continued to push the frontier boundary (Burke, 1982; Fonseca & Andrews, 1993). Initially and for some time, the higher education institutions, particularly in the New England states, were few and persistent due to protections provided by the charter granting church-states (Meiners, 1995; Tewksbury, 1932). As the population of the union grew and expanded, particularly in those states where churches and religion were less a central part of the government, towns tended to compete vigorously to establish colleges as an outward demonstration of their potential (Meiners, 1995).

*Figure 1*: Oldest Colleges: Those founded before 1800 (Fonseca & Andrews, 1993, p.21).
Tewksbury (1965) states that he was able to identify two classes of higher education institutions prior to the Civil War; those he considered permanent (totaling 182) (Figure 2) and a significantly larger number (up to 1,000) that he regarded as essentially temporary. In the majority of cases, those temporary colleges and universities were small, typically having only one teacher, and had a high mortality rate (Meiners, 1995; Tewksbury, 1965). Tewksbury (1965) also characterized the typical higher education institution in the developing U.S. as “frontier institutions” that were a manifestation of the desire to support the spread of Christianity, along with the westward expansion, by providing a means for maintaining an educated ministry at the nation’s frontier. Burke (1982), however, contests the validity of statements regarding the mortality rate during that time period and further contends that there were more factors involved in the founding and distribution of new colleges in the first half of the 19th century than simple expansion of the union.

The two decades immediately preceding the Civil War saw the expansion of another national resource; the railway. In 1830, the total railway mileage in the United States was 23 miles. By 1840 the amount of track laid increased the total mileage to 2,818. Ten years later, in 1850 there were 9,021 miles of track laid in the U.S. (Kelly, 1921). Kelly (1921) in his report to the Association of American Colleges on the distribution of colleges in the U.S. states that transportation routes in the U.S. had a definitive influence on the location of higher education institutions through the latter half of the 19th century. In fact, Kelly (1921) asserted that there was evidence that colleges in America were far more strategic in their locational decision making than previously
believed. As evidence, Kelly (1921) used a series of maps showing the location of transportation routes and development of colleges over the 30 year period from 1850 to 1880. The first map he presents (Figure 3) shows both rail and common roads through the U.S. and associated territories, along with the locations of colleges in existence at the time.

Figure 2: One Hundred and Eighty-two Permanent Colleges and Universities Founded Before the Civil War (Tewskbury, 1965).

While Kelly (1921) stated that few colleges were on rail routes in 1850, he did identify a tendency for colleges to locate along established travel routes. Interestingly he also identified that there were numerous exceptions to the tendency established prior to 1850. This is congruent with earlier denominational suppositions that students attending colleges would be better served in locations somewhat removed from more populous
areas, where the proximity and temptation to sin would be lessened (Adams, 1998; Schofer, 1971; Westmeyer, 1997). Kelly (1921) goes on to say that of the 80 colleges founded in the U.S between 1850 and 1860, 70 were founded in states with railroads and only ten were founded in states without.

Figure 3: Colleges and Methods of Transportation in the United States in 1850 (Kelly, 1921).

It was the temporary dissolution of the union between 1861 and 1865, also known as the Civil War, which made possible the next step in the geographic distribution of higher education in the U.S.; the passage of the Morrill Act of 1862. While it is commonly believed that the basis of the Morrill Act was a need within the union for accessible higher education in agriculture and the “practical arts”, the foundation of what came to be such a landmark act is more appropriately credited to timing and federal
economic interests (Johnson, 1981; Key, 1996). Representative Justin Morrill of Vermont originally introduced the idea of granting federal lands to states for the establishment of colleges of agriculture and the mechanical arts in 1858. At that time, the legislation was heavily contested in Congress, from the southern Congressional Representatives in particular, and then vetoed by President Buchanan (Hofstadter & Hardy, 1952; Key, 1996). According to Key (1996), the prevailing attitude in Congress at that time was that the highest and best use of Federal land was to sell it off as necessary to repay the Federal debt. As the Civil War broke and the Southern delegates departed Congress, and with the election of Abraham Lincoln, the opposition to Morrill’s bill waned (Hofstadter & Hardy, 1952; Rydell, Safford & Mullen, 1992).

The Morrill Act of 1862 established land-grant institutions for the “endowment, support, and maintenance of at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanical arts…” (Sec. 4). Each state in the Union at that time, which excluded the withdrawn Southern states, was granted 30,000 acres of federal land for each member of the states congressional delegation which was to be sold. The proceeds of those sales would then be used to found and maintain that states land-grant institution (Key, 1996). The result was provision of the financial means and incentive necessary to geographically distribute higher education across the national landscape. Still, the overriding justification for the bill had less to do with providing access to higher education for the masses, than providing for the long term reduction of the Federal Government’s accumulated debt by
encouraging the generation of increased agricultural income which they could tax (Key, 1996).

The completion of the first Transcontinental Railway at Promontory Summit in 1869 is often considered a metaphor for the post Civil War coming together of the nation. According to Kelly (1921) it also provided the local geographic foundations necessary to support the development of sustainable colleges and universities during the near decade of its construction. He notes that during that period all but five higher education institutions founded west of the Mississippi were located on or near that rail line (Figure 4). In the decade that followed, with its continued explosion in rail growth, Kelly identifies the proximal development of railways and colleges (Figure 5) as further evidence of the significant association between the two and the reasoning behind the geographic distribution of the nation’s higher education resources to that point.

Figure 4: Transportation West of the Mississippi – 1870, and Colleges Established in the Decade 1860-1870 (Kelly, 1921).
If higher education up until the mid-nineteenth century could be said to be the age of private, denominational institutions (Council of State Governments, 1952); it could be said that the years between the Civil War and the First World War belonged to the land-grants (Westmeyer, 1997). While 21 public colleges effectively functioned in 20 states prior to the Morrill Act, within nine years of the passage of that legislation 36 states had agreed to terms of the law (Council of State Governments, 1952; Williams, 1997). By 1890, only 28 years after the Morrill Act passed, 69 land-grant institutions had been established (Goodchild & Wechsler, 1997). As mentioned previously, the land-grant system did establish a pattern of geographic distribution of higher education institutions at the national scale. In other words, it provided for the location of at least one college or university in each of the (ultimately 50) states.
However, beyond the geographic patterning at the national scale, some contend that within states the issue of locating the land-grants had little to do with geographic planning (Schofer, 1975). To be sure, the agriculturally based mission of these institutions generally necessitated their location in more rural locations within states (Adams, 1998). However, aside from the potentially spurious relationship between the development of the rail infrastructure and the locating of colleges offered by Kelly, to suggest that there is a geographic aspect to the location of land-grant colleges and universities within each state would be misleading. Politics was a more likely determinant of location within states than geographic planning (Roggeveen & Thompson, 1968; Shofer, 1971). According to Johnson (1981), “Many were ploys in the legislative maneuvering for scattering internal improvements around the state, with ‘equitable’ distribution of college, capitol, penitentiary, insane asylum, and normal school” (p. 341).

As an example of the process states engaged in to site their land-grant institutions, Rydell et al. (1992) describes the “dispersal of its political plums” (p. 4) by the Montana State Legislature, to include The Agricultural College of the State of Montana, now Montana State University, in 1893. Rydell et al. further state that “Bozeman’s success in securing the agricultural college capped three decades of feverish community building by a group of individuals bent on incorporating the Gallatin Valley and southwestern Montana into the national industrial economy and the national cultural landscape” (p. 4). Further, “Bozeman’s elite began dreaming of a college that would transform their town into ‘the Athens of the West.’…promised stability – and held out the larger promise of
bestowing a measure of legitimacy to their own rise to positions of influence and power” (p. 7).

From the geographic standpoint, the next period of significant interest in higher education development extended from the start of the 20th century to the Second World War. While the period during World War I saw a rapid decline in the establishment of new institutions (Greenleaf, 1930; Lunden, 1939) and nearly universal decline in higher education enrollment in the U.S. that threatened the closure of colleges across the country, the very nature of the conflict brought new purpose and potential to the institution (Levine, 1986). It was with the conclusion of the First World War and the shift in societal conceptions regarding higher education that the junior or community colleges began to proliferate (Levine, 1986; Lucas, 1994; Pedersen, 1997). While the “utilitarian” period of higher education is typically associated with the development of the rurally located land-grant institutions, the broader philosophical ideals were assumed by junior colleges at the start of the new century as a way to tie themselves to their generally small, but not rural local communities (Hutchenson, 1999). So while four year institutions, particularly the urban universities (Levine, 1986), tended to expand in size rather than number (Greenleaf, 1930), from 1900 to 1921 the number of junior community colleges went from eight to 207 (Thornton, 1972). In 1934 that number had further increased to 349 (Greenleaf, 1934), and by 1940 there were 456 junior colleges in the U.S. (Levine, 1986).

The shift from the upstart urban universities and more pastoral locations historically preferred for the establishment of higher education institutions to the small
town locations associated with junior/community colleges is often allied with the concept of providing educational opportunity to the everyman or second tier students. It should not be forgotten that a significant and expansive social and locational transformation was underway during this period as economic opportunities in rural areas declined and urban opportunities expanded (Frye, 1992; Levine, 1986). While some saw the junior/community colleges as an opportunity to relieve “true” colleges of the burden of less able students (Frye, 1992; Levine, 1986), others simply saw them as expanding educational opportunities for students with fewer resources (Monroe, 1972).

At the regional scale, the predominant location of these institutions in perhaps remote, but somewhat populated areas is usually linked with the idea that less affluent students did not have the resources to travel to otherwise distant universities (Neufeldt, 1982; Thornton, 1972). The expansion of junior/community colleges in the populated hinterland areas is also based on the fact that these institutions were in most cases both philosophically and functionally considered expansions of the secondary school system (Frye, 1992; Medsker & Tillery, 1971; Monroe, 1972). Geographically speaking, an interesting note is that despite the rhetoric of the time that junior/community colleges could and would provide a terminal education for the predominant middle class of students, the two year institutions remained conspicuously absent from locations already being served by the four year colleges and universities (Frye, 1992).

On the national scale, the western and midwestern states were the pioneering areas in the large scale development of junior/community colleges. California, Texas, Iowa, Kansas, Oklahoma, and Minnesota were at the forefront in the establishment of
community colleges (Frye, 1992; Greenleaf, 1930; Medsker & Tillery, 1971). California and Texas in particular dominated in the number of junior/community colleges established (Frye, 1992). In California this seems to have been driven by the interests of a few “champions” of the junior/community college movement and their ability to carry it to state institutionalization through the political process (Monroe, 1972). The spatial distribution of these institutions nationally was also impacted by variances in state level laws and policies and the individuals in those states willing and able to take up the mantle. However, also on the national scale, it has been proposed that a significant correlation exists between the development of junior/community colleges and significant population growth within those states which was attributed to internal migration, rather than foreign immigration (Frye, 1992).

The community college movement clearly dominated the geographic landscape of higher education in terms on the number and dispersion of the institutions prior to the Second World War. However, it provides only medial comparison to the impact of the Serviceman’s Readjustment Act of 1944 (Public Law 346), otherwise known as the GI Bill of Rights (Bound & Turner, 2002). While the concept of access to higher education after the First World War was central to the development of the junior/community college system, the means to access provided by the GI Bill expanded the pool of higher education seeking citizens well beyond the existing capacity. The time honored response of expanding existing institutions was simply insufficient to accommodate the new demand, thus the roughly 1,800 institutions in existence in 1947 ballooned to approximately 4,216 by 2004 (NCES, n.d.; Trow, 1989) (Figure 6).
Certainly much has been written about the expansion of higher education in the US from the close of the Second World War to the latter part of the 20th century (Best, 1988; Burke, 1982; Freeland, 1997). The vast majority of the literature focuses on enrollment growth in various sectors; both demographic (gender, race, age) and institutional (public/private, junior college/four-year). Some few have also touched at the periphery of locational analysis by suggesting that this period was dominated by the rise of the urban institutions at all levels (Adams, 1998). Indeed, a fair amount of data exists indicating how many and what type of institutions where founded at the state level (NCES, n.d.) and Adams (2000) has identified other data sources capable of providing...
county level locations. It is conceivable that someone could develop a database identifying the locations of active institutions and their date of founding by combing their web sites and or surveying the institutions in the IPEDS database. However, thus far a comprehensive study of the spatial dispersion of higher education institutions during the mid 20th century to present is lacking. Preliminary work by Adams (1998, 2000) indicates that this situation may soon be rectified.

Higher Education Enrollment, Demographics & Institutional Choice

As might be expected, enrollment trends in higher education in the U.S. since its inception correlate closely with the number of institutions founded over time with the likelihood being that the interest, or at least perceived interest, of larger groups of potential students resulted in expansion of the national higher education enterprise (Hall, 1995). There is no deficiency in the literature regarding most aspects of higher education enrollment over time. Generally speaking, student enrollment in colleges and universities slowly but steadily increased from the founding of Harvard to its first significant bump after the First World War, followed by a second, more pronounced increase after World War II. The 60’s and 70’s further ushered in spectacular increases in the population of students attending institutions of higher education (Figure 7). Enrollment in its totality has been cataloged, studied and predicted by concerned organizations and constituencies for at least a century (Burke, 1982; Carnegie Commission on Higher Education, 1971; Council of State Governments, 1952; Kelly, 1921; NCES, n.d.). The enrollment patterns and growth of minority participants has also been thoroughly documented (Bowles & Decosta, 1989; Kao & Thompson, 2003; Olivas, 1982; Olivas, 2005; Willie & Cunnigen,
as has the inclusion and increase in the number of women in higher education (Fass, 1997; Ogren, 1995; Touchton & Davis, 1991).

![Figure 7: Historical summary of student enrollment in higher education institutions from 1869-2004 (NCES, n.d.).

Given the extensive coverage of various segments of higher education enrollment and the objectives of this research, it seems of little purpose to try and summarize the various enrollment trends over the past three and a half centuries. However, what does seem appropriate and more directly related to this research is to examine what the literature says about the relatively new online student population and how it may differ from existing or previous college student populations. It is this population of (perhaps) non-traditional and/or Gen X-ers and/or Generation Y (a.k.a. the Millennials or the
Internet Generation) students that seems to have turned the tables on the drivers of higher education growth. Where it once appeared that institutions developed to accommodate growth (Hall, 1995), it now appears that to sustain institutions administrators are trying to maintain or expand their student population by appealing to un(der)served markets or markets new to the institution (Eckel & King, 2004; Hall, 1995).

Lewis, Alexander and Ferris (1997) claim to provide the first national compendium of distance education enrollment data for the United States. In their report, based on a survey of institutional enrollment for the 1994-1995 academic year, they identify the national online enrollment to have been 753,640 students. That figure is somewhat skewed as it is actually based on course enrollments as institutions were asked to count students enrolled in multiple courses once for each course in which they were enrolled. To provide some context for that number relative to total higher education enrollment in the U.S., there were 14.3 million students enrolled in the fall semester of 1994 (NCES, n.d.). Thus, roughly five and a quarter percent of the total student population was engaged in distance education in the ’94-’95 academic year. Of those students taking distance courses, 55% were enrolled in public 2-year institutions, 31% in public 4-year institutions, and 14% in private 4-year institutions By region, the West accounted for the largest proportion at 37%, followed by the Central and Southeast regions both enrolling 27%, and finally the Northeast region which enrolled 10% of those students (Lewis et al., 1997).

The 1999 follow-up to Distance Education in Higher Education Institutions (Lewis et al., 1997), Distance Education in Postsecondary Education Institutions: 1997-
1998 (Lewis et al., 1999), provides the first glimpse of the enrollment growth and potential of distance education in the U.S. In the three years between studies, the enrollment in credit-granting distance courses had grown to 1,343,580 and enrollment in all distance education course had more than doubled to 1,632,350 (Lewis et al., 1999). Total enrollment growth was most pronounced in the public 4-year higher education institutions which roughly tripled their course enrollments from 1994, capturing 43% of all enrollments. Public 2-year institutions were still “market leaders” with 44% of the total enrollment and private 4-year institutions still a distant third with 13% of the enrollments. For credit earning courses, the proportions are more similar to the 1994 data: 51% were received from public 2-year institutions, 34% from 4-year publics, and 15% from 4-year private institutions of higher education.

The third publication in the Nation Center for Education Statistics trilogy, Distance Education at Degree-Granting Postsecondary Institutions 2000-2001 (Waits & Lewis, 2003), identified roughly another doubling in the nations distance education enrollments. For the 2000-2001 academic year, enrollment in all higher education distance delivered courses had risen to 3,077,000. Enrollment in credit-granting courses had grown to 2,876,000. In terms of institution types, the greatest enrollment growth occurred in the private 4-year institutions (21% of all distance enrollments and 19% of enrollments in credit-granting courses). Public 2-year institutions maintained their enrollment dominance with 48% of the total course enrollments and 50% of the enrollments in credit-granting courses. The public 4-year post-secondary institutions enrolled 31% of the students in all distance courses and 31% of those enrolled in credit-
granting courses. Interestingly, the 2000-2001 data showed a decrease in the proportion of credit-granting courses offered, 76%, from the 1997-1998 proportion, 82%. Figure 8 provides perspective on the proportional increase of the reported distance education enrollment growth compared to the total enrollments.

![Figure 8: Enrollment in distance delivered courses compared to total enrollment in post-secondary, Title IV institutions (Lewis et al., 1997, Lewis et al., 1999, Waits & Lewis, 2003).](image)

In a similar series of reports, Allen and Seaman (2003, 2004, 2005, 2006, and 2007) identify annual enrollments in online courses from 2002 through 2006 (Figure 9). They define an “online course” as one where 80% or more of the content is delivered online and there are generally no face-to-face meetings. What is not clear is how they
define “students”; in other words, is a “student” a single individual who may be enrolled in multiple courses or each individual enrolled in each course. While none of the variables appear to be directly comparable with the NCES sponsored reports on distance education (the definition of which is inclusive of, but extends to delivery methods other than online delivery), the trends are clearly similar. Thus we can conclude with some assurance that there has been a consistent overall increase in the population of students engaged in the learning process beyond the confines of the physical space defining the institution they “attend”. There also appears to be consistent data over the past decade that the proportion of students engaged in distance delivered education in general and online learning specifically has steadily increased relative to the total number of students engaged in higher education. According to Moloney and Oakley (2006) we should expect continued annual growth of approximately 20% for the next few years.

So we can expect enrollment in distance and specifically online courses to continue to grow. Who are these students taking advantage of the continuously developing venue? At first glance, the distance education literature identifies the typical distance student as an adult learner (over 25 years of age) pursuing (more often than not) her education either on a part-time basis, or who is geographically distant from the higher education institution where she is enrolled, or both (Grubesic & Oliver, 2003; Moore & Kearsley, 2005; Palloff & Pratt, 2003; Wallace, 1996). While many works have contended that this model of the distance learner is fact (Garrison & Shale, 1990; Holmberg, 1995; Moore & Kearsley, 2005; Qureshi, Morton & Antosz, 2002), others
suggest that while this may be historically true, it is no longer exclusively the case (Guernsey, 1998; Grubesic & Oliver, 2003; Palloff & Pratt, 2003; Wallace, 1996, 2002).

Figure 9: Online course enrollment compared to total enrollment in degree-granting institutions of higher education (Allen & Seaman, 2003, 2004, 2005, 2006, 2007).

More specifically, Wallace (1996, 2002) and Guernsey (1998) state that distance students now come in two models and the newer of the two is growing at a greater rate and more closely resembles what is typically referred to as the traditional campus based population. Pascarella and Terenzini (2005) define the traditional population as “White undergraduates, ages 18 to 22, who attended four-year institutions full-time, lived on campus, did not work, and have few, if any, family responsibilities” (p. 2). Of note is the fact that these same traditional on-campus students are themselves growing less
traditional each year and may in fact be the exception rather than the rule (Choy, 2002; Van Dusen, 1998). So while distance students are becoming more traditional, campus based students are more non-traditional (Speer, 1996).

Several authors (Howell, Williams & Lindsay, 2003; Pascarella, 2006; Reason, 2003) state that post-secondary student characteristics in the U.S. have changed significantly and have become increasingly diverse across all dimensions (age, race, work and family commitments, etc.) in the past decade. So, while there continues to be a population “out there” that conforms to the characteristics traditionally ascribed to distance learners, Wallace (1996) indicates that the “next” wave is composed of distance learners who are predominantly (65% in her study) under the age of 26, are concurrently registered in distance and on-campus courses, and tend to reside within proximity to the institutions they are enrolled in at a distance though the archetypal dominance of women engaged in distance education continues. Roach (2002) also estimates that half of the students in online courses are in the 18 to 25 year old age range that would otherwise be enrolled in campus based courses.

To be sure, Oblinger, Barone and Hawkins (2001) identify multiple distance learning segments including: corporate learners, professional enhancement learners, degree-completion adult learners, college experience learners, pre-college learners, remediation and test preparation learners, and recreational learners. However the segment specifically associated with the current predominant growth market for higher education online courses appears to be some combination of the degree completion adult learners (non-traditional students) and the college experience learners (traditional students).
Allen and Seaman (2007) further compare the ratios of online to campus based students by level. Generally speaking the proportion of students enrolled in undergraduate, professional degree and graduate courses is similar between online and campus based populations with slight variations. In 2005, undergraduates online made up 82.4% of the online student population while on campus the proportion was slightly higher at 85.6%. For professional degree courses, the proportion was also slightly lower for the online population (1.2%) than the campus students (1.9%). It was within the graduate student population that the online proportions exceeded the on-campus proportions with 14.0% online and 12.4% on-campus (Allen & Seaman, 2007).

Phipps and Merisotis (1999) lament the fact that most research on distance education has been conducted on groups of distance and traditional learners rather than looking at the variables shared between the groups as well as the variability within the groups. While their disappointment is relative to the context of learning outcomes, the literature indicates that there is growing homogeneity between the student groups across some dimensions. Specifically, it appears as if the entire higher education student market is becoming more diverse, rather than two distinctly heterogeneous distance and on-campus populations (Guernsey, 1998; Grubesic & Oliver, 2003; Palloff & Pratt, 2003; Wallace, 1996, 2002). The expanding homogeneity also applies more broadly to the design and outcome of courses, as well as the organization, structure and policies of institutions (Keller, 2001).

Having a better understanding of who online students are, or are becoming, allows us to explore the next question regarding how they are choosing the institution and mode
of content (course or program) delivery. In reality, what drives individual’s choice of institution and choice of course delivery mode are two separate, but related, questions. In some cases one decision resolves both questions. Small, 4-year liberal arts institutions have the most negative opinion towards online education and are therefore the least likely to offer any of their courses online (Allen & Seaman, 2007). So a student electing to enroll at a small liberal arts institution is by default deciding to forgo opportunities for formal online learning opportunities at that institution. By contrast, over 96% of institutions with enrollments greater than 15,000 students provide some online courses and/or programs (Allen & Seaman, 2007). This does not mean that students at those larger schools will take online courses, only that the opportunity to do so is significantly more available, acceptable, and perhaps even expected.

How students choose which higher education institution they will attend has been approached from multiple disciplinary perspectives since at least the 1970’s (Paulsen, 1990). At various times psychologists, sociologists, economists, geographers and higher education researchers have all studied the question from their various perspectives (Leppel, 1993; Paulsen, 1990). Psychologist have traditionally looked at college choice from the perspective of assessing the impact the experiences and environment has on students. Sociologists have looked principally at those factors that influence a prospective student to consider attending college/university in the first place. As might be expected, economists typically look at college choice from the perspective of investment and cost-benefit analysis (Paulsen, 1990). Geographers have generally taken an economic geography approach looking more specifically at costs associated with distance and
gravity modeling (Kariel, 1968). Given those particular perspectives, it is not surprising that the various disciplines then end up looking at what are generally considered the three phases of the college choice process: predisposition or aspiration formation, search and application, and finally selection and enrollment (Hossler & Gallagher, 1987; Jackson, 1982).

More recently, the question of what factors influence student choice of higher education institution has been of great interest within higher education because knowledge of the answer provides institutions with the opportunity to develop a competitive edge in recruiting and enrollment (Chapman, 1981; Goenner & Pauls, 2006; Paulsen, 1990). Thus, knowing why potential students choose the way they do, provides institutions with some of the same potential benefits that offering distance delivered courses and programs might – more (of the “right”) students. Paulson (1990) summarized what he refers to as the macro level significant variables (environmental characteristics used to forecast total enrollment) identified in the literature as: Demographic Picture, Job Market Benefits of College, Opportunity Costs of College, Size of Armed Forces, Direct Costs of College, Competition, Location, and Curriculum. At the micro level (those institutional variables influencing the decisions of individual students) the following characteristics increase institutional attractiveness: lower tuition, greater availability of financial aid, lower costs for room and board, decreased distances between home and school, higher admissions selectivity, and more curricular offerings (Paulson, 1990). An interesting addendum that differentiates the important enrollment variables for traditional and non-traditional students is that while distance from home is also important to non-
traditional students, it is within the context of convenience and time, rather than expense (Bers & Smith, 1987).

Certainly there are a number of variables that influence groups of or individual student’s decisions to attend particular institutions. One of the consistent variables is distance of the institution from the student’s point of origin (Anderson et al., 1972; Frenette, 2006; Goenner & Pauls, 2007; Kariel, 1968; Kiecker, 2004; Leppel, 1993; Weiler, 1994), which is, by extension, a measure of the institution’s centrality. Leppel (1993) has stated that distance is important in the school college choice decision for the following reasons: 1) the inverse relationship between distance and information – as distance between the potential student’s residence and a given institution increases, knowledge regarding that same institution decreases, 2) the direct relationship between distance and cost – it costs more to travel farther, 3) the fact that as distance from a student’s home increases the likelihood and number of alternative institutions increases, 4) The psychic or emotion costs (home sickness) increase over distance, and 5) the possibility of “bandwagon” effects. The last reason, the bandwagon effect, has also been referred to as a peer-influence effect by Kiecker (2004) and a “birds of a feather flock together” effect by Goenner and Pauls (2006, p. 936). In geographic terms it could also be called positive spatial autocorrelation; that students nearer each other tend to be more similar and want similar things than students farther away from each other.

The question of how important distance is through the three phases of the decision process is still up for debate. Based on the gravity modeling of spatial interactions he conducted on Western Washington State College, Kariel (1968) found that he could
effectively predict student enrollment based on applicant’s distance from the institution. Leppel (1993) has stated that for the private college she studied, it was the most important determinant in the final phase, enrollment. Presumably, at the point where the decision is being made between a handful of finalists, the applicant has distilled the institutional options into a fairly uniform group principally distinguished from each other by the relative distance from the applicant’s home of record. Chapman (1981) states more explicitly that over 50% of incoming freshman students enroll at higher education institutions within 50 miles of their home of origin. More recently, the National Center for Education Statistics (n.d.) reported that 81% of the fall 2004 freshmen in the nation who had graduated from high school the previous year were attending higher education institutions in their home state. Similarly, the Condition of Education 2008 report states that in 2006 the in-state attendance of freshman nationally was 74.6%, up from 74.0% in 1996, and with significant regional patterning (Planty, Hussar, Snyder, Provasnik, Kena, Dinkes, KewalRamani & Kemp, 2008).

Historically, even knowing why students choose which institutions to apply to and ultimately enroll at can only be so effective because there are things that institutions can or will change/accommodate and things that they cannot or will not (Chapman, 1981). For example, through the late 1970’s with student consumer’s interest in increased vocational and professional training, a number of institutions changed the content or the size of the programs they offered to match the market demand (Stadtman, 1980), being everywhere to minimize the distance/locational costs associated with enrollment at a given institution has been less practical (until recently). Regardless of the overall amount
of variability that distance contributes to the choice process, it is of particular interest relative to distance education for two reasons: 1) Once an institution fixes its location, it becomes static and becomes a slave to the ebb and flow of potential students proximate to its location unless it incurs substantial costs associated with developing branch campuses, and 2) The promise of distance education is/was to eliminate the constraints of spatial location.

When looking at choice of mode of educational delivery, the principal variable typically put forth revolves around geographic constraint (Berg, 2002; Eaton, 2001; Grubesic & Oliver, 2003; Schneider & Germann, 1999). As already discussed, distance education was developed for those geographically remote, non-traditional students whose responsibilities prevented them from relocating to attend courses or participate in programs at the sites where higher education institutions exist. While historically, that model may in fact be the dominant one, a significant paradigm shift has occurred in the past few years. More and more research is suggesting that it is no longer the geographically remote students who dominate the distance learning market, but that the significant growth can more readily be ascribed to students seeking relief from temporal constraints (Berg, 2002; Cavanaugh, 2005; Eaton, 2001; Grubesic & Oliver, 2003; Guernsey, 1998; Moore & Kearsley, 2005; Scarafiotti & Cleveland-Innes, 2006; Washburn, 2001). In other words, the complexity of students lives (i.e. family and/or work responsibilities, schedule conflicts with campus course offerings) and or the complexity of their environment (i.e. time it takes to get to a campus location through
traffic, cost and/or availability of parking) provide enough of barrier that even those generally proximate to institutions opt to participate via online offerings.

In their 2003 study of distance education in the Virginia Community College System, Grubesic and Oliver found that the majority of the distance students were clustered near the campuses they were taking courses from, though the more rural institutions tended to draw their distance students from a broader geographic area than their urban equivalent. Another way of looking at it is to say that the majority of the distance students were enrolled in the institution located nearest to them (Figure 10). While they also identified that geographic distance decay applied to the Virginia Community College online context (Figure 11), it only declined out to the 20-25 mile distance. The authors speculate that the increased percentage of student enrollment shown out at beyond the 25 mile mark is a function of the spatial dispersion of the population of the state relative to the location of the institutions such that 6.6% of the population of the state, or 463,000 state residents, lives more than 25 miles from the nearest institution.

While it is true that a significant proportion of the higher education student population in the U.S. is enrolled at the community college level, it is important to keep in mind that the context of the Grubesic and Oliver (2003) study is limited and probably not generalizable to a broader scale. In fact, Moloney and Oakley (2006) state that the online market is separating into tiered markets; one regionally based, the other national. The regional market is based on the population of students who when presented with a
Figure 10: Percent of Distance Education Students Enrolled at Nearest College (Grubesic & Oliver, 2003).

Figure 11: Distance Decay Curve (Grubesic & Oliver, 2003).
multitude of otherwise equal options (institutions offering the same online courses at about the same price and product quality), will choose the one they are most familiar with, which in most cases will be the institution nearest to them (Garrett, 2007). The national market is somewhat more complex because it may be composed of institutions offering either unique classes (or more likely complete programs), institutions with national reputations for exceptional quality in given programs, and/or institutions like the University of Phoenix and Capella University that have been able to brand themselves as national institutions. Molony and Oakley (2006) and Garrett (2007) speculate that the majority of the online growth will occur in the regional market, which is consistent with Grubesic and Oliver’s (2003) work.

Higher Education Finance & Distance Learning

Most higher education institutions receive their funding from one or a combination of the following three mechanisms: 1) student tuition, paid for from family savings, current income and financial aid (Lee, 1999) from private loans and/or State and Federal government student aid programs, 2) state appropriations, and/or 3) grants and contracts (the majority of which are doled out through federal programs). States, which hold the mandate to provide an education for their citizens, spent just under $72.2 billion for higher education operating expenses in 2006-2007 and in 2005-2006 spent $8.5 billion on student aid to provide and maintain higher education within their borders (Almanac, 2007). Federal student aid for 2005-2006, composed of grants, loans, work study and education tax benefits, was estimated to be $94.3 billion (College Board, 2006a). Additionally, in fiscal year 2005 the Federal Government obligated $25 billion
dollars to higher education for research and development in the sciences and engineering alone (Almanac, 2007). Despite the huge State and Federal expenditures for direct funding to institutions identified above, the share of the costs of higher education covered by public appropriations has declined in recent years with a corresponding increase in the share covered by tuition and fees (College Board, 2006a, 2006b; Rizzo, 2006).

Financial resources to support higher education have been growing increasingly scarce (Black, 2003; Bok, 2003; Farrell, 2004; Gallick, 1998; Heck et al., 2000; Kirp, 2003; Layzell, 1999; Mortenson, 2001; Nerad and Miller, 1996; Rupert, 1997). One of the results of increasing financial pressure has been for institutions to explore programmatic differentiation or expansion that offers the greatest potential for increasing “profit margins” (Bok, 2003; Foster & Carnevale, 2007; Kirp, 2003; Palloff and Pratt, 2003). Accordingly, many institutions have launched significant initiatives to develop distance delivered courses and programs based on the premise that they can capture new “market” to supplement their campus based enrollment (Bok, 2003; Dibiase, 2000; Lake & Pushchak, 2007; Lewis et al., 1999). However, the volume of conflicting assertions regarding the costs associated with the development and delivery of distance courses indicates that those costs are either hard to disaggregate and quantify or vary significantly from institution to institution based on size, administrative structure, regulatory policies, faculty composition, preexisting technology investments and several other factors (Boettcher, 2000; Finkelstein & Scholz, 2000).

The overall number of high school graduates is expected to increase nationally until 2010 (College Board, 2005). This, along with the relative standstill in the number of
new brick and mortar institutions being founded on an annual basis, might signal that enrollment managers should have an easy time maintaining if not growing their enrollments for the immediate future. However, rapidly increasing costs to maintain higher education institutions (College Board, 2006b), the complexity of regional differences in the number and characteristics of those secondary school graduates (College Board, 2005), the cost for tuition and fees escalating at a greater rate than the median household income (College Board, 2005, 2006b), and ever increasing numbers of non-traditional students pursuing higher education opportunities have resulted in a competitive scramble amongst all but the top-tier of institutions (Bok, 2003). With increased competition in the higher education market, consumers have much greater ability to take their business to the provider that is most responsive to their needs. So institutions have gone beyond simply selling the product they have and have engaged in developing new products to sell to new markets (Bok, 2003; Kriger, 2001).

There is little dispute regarding whether a profitable market for distance education exists. The Primary Research Group (2007) estimated that revenues from distance learning programs increased 15.52% on average in 2006. For their sample of 45 institutions, the mean annual revenue from distance courses/programs was $2.35 million (Primary Research Group, 2007). The University of Phoenix Online, the distance learning arm of the for-profit higher education institution founded in 1979, now has the largest enrollment of any college in the U.S. at 117,309 students (Almanac, 2007). It is also the beneficiary of the largest amount of federal student aid funds, $1.8 billion in 2004-2005, in the U.S. (Lewis, 2007). Though its earnings have slowed consistently since 2001 due
to ever increasing competition (Foster & Carnevale, 2007), it’s 2001, 2002, and 2003 earnings growth for online programs of 81%, 70% and 61% are still impressive (Farrell, 2004). On the public side, the University of Massachusetts online education program, UMassOnline, recorded a 25% increase in their enrollment and 32% growth in their revenue for FY 2006. Their total revenue for FY 2006 from online programs reached $28 million (UMassOnline, 2007). As discussed earlier, continued increases are expected in the enrollment trend for distance learners (Allen & Seaman, 2007; Foster & Carnevale, 2007; Maloney & Oakley, 2006).

Despite the growth potential of the market and the latent profitability delivering online courses/programs, Berg’s (2002) survey of higher education administrators illuminated an interesting contradiction in stated motivations for institutional engagement in distance learning. When given seven choices to identify their institutions motivation for pursuing distance education programs, relatively few identified its potential as a new source of revenue as a motivating factor. However, when asked explicitly if the development of new programs was motivated by the pursuit of new sources of revenue, only 18.2% of the respondents rejected the idea as part of their institutions motivation. When broken into Carnegie classifications, doctoral degree granting institutions had the highest proportion, 56.4%, of “yes” responses. Further, Vignare, Geith & Schiffman (2006) report in the results of their non-representative survey of 110 institutions, heavily weighted towards public institutions that offer advanced degrees, that the desire to return a surplus to the institution was one of the principal reasons for offering online learning.
Quality distance education requires significant investments (Bok, 2003; Ennew & Fernandez-Young, 2006; Kershaw, 1999; Kriger, 2001). The literature also indicates that successful implementation of distance programs requires significant shifts in institutional cultures in order to serve the new clientele to their level of expectation (Berg, 2002; Moore and Kearsley, 2005). A host of administrative issues need to be addressed during the institutional transformation process. Issues such as: how course development will be funded, support for faculty and student technical assistance, how resources may flow back to academic departments that provide faculty to teach online who would otherwise be teaching in campus classrooms will challenge the existing structure of most institutions (Miller & Schiffman, 2006; Hanna & Oaks, 2007).

**Higher Education Location Theory & the Promise of Eliminating Spatial Constraints**

While the spatial location of higher education institutions has been examined from the planning perspective since at least the early 19th century (Kelly, 1921; Roggeveen & Thompson, 1968), very little work has been done that attempts to marry the spatial distribution of higher education institutions to the classic geographic location theories and modeling literature. In part this may be because higher education has historically been viewed as much more than, if not simply above, an economic activity, which has traditionally been the focus of that body of work. In some ways it might also have been subsumed, with minimal consciousness, into the exploration of the spatial distribution of administrative systems by some of the geographic theorists (Kershaw & Safford, 1998). While the literature is not completely bereft on the subject (Schofer, 1971, 1975; Kershaw & Safford, 1998), it is worth exploring the theoretical
underpinnings and limited literature in order to place the proposal that online education will eliminate geography into context.

Theories and the models that evolve from them are representations or approximations of complex systems that rarely precisely explain or allow the prediction of specific occurrences (Golledge, 1996). As Golledge (1996) further states, the value of theories and their associated models lays in the necessity for logical formulation (Barnes, 2003) and understanding of the “legitimacy and validity of the inferences made” (p. 463). While geographic theories have not been particularly effective at explaining or predicting the realities we see across various landscapes, they have provided a geographic context within which to view various kinds of environments where people and organizations interact.

The reason for looking at some of the classic location theories that have evolved is to try and better understand the possible impact that a spaceless environment like the internet can have on an otherwise geographically situated enterprise like higher education. Levine (2000) explored that very question when he said:

Many countries built systems of higher education based on propinquity, trying to build a campus in easy proximity of every citizen. How long will it be before nations ask why they have so many campuses? How long before they ask higher education to request new technologies, not new building? (¶ 21)

The goal of location theory has fundamentally been “to explain the impact of space on social and economic activity” (Golledge, 1996, p. 469) and has principally
grown out of the sub-discipline of economic geography. The essential idea is that enterprises will locate at locations that minimize costs or maximize profits (Ellinger, 1977). Krumme (2000) identifies four classical location traditions, which include: Land-Use Theory, Industrial Location Theory, Central Place Theory, and Spatial Competition and Competitive Differentiation. Based on micro-economic reasoning and its associated assumptions, the underpinnings of these theories have seen resurgence since the 1990’s when economists began to recognize the role space can play in economic development (Barnes, 2003; Krugman, 1999; McCann & Sheppard, 2003; Neary, 2001).

In 1826, Johann Heinrich von Thünen wrote *The Isolated State* (1966), defining the foundation of Land Use Theory and becoming the “father” of location theory and the concept of the “economics of space” (Blaug, 1985, p. 615; Blaug, 1990). This treatise postulated that, within the bounds of numerous assumptions associated with a homogeneous and isolated landscape, the price of a given product and the locations where that product is produced would be a function of its distance from the market (Golledge, 1996). He further speculated that spatial area was important because there are defined geographic limits to the markets for any given product (Blaug, 1985). Within the framework of higher education, one could apply this theory to both the community college movement and the development of urban colleges.

The initial conceptualization of Industrial Location Theory, or attempt to identify the ideal location for a plant which would produce a defined product, is attributed to Carl Launhardt (Blaug, 1985; Pinto, 1977) based on his 1882 paper, *The Determination of the Practical Location of an Industrial Enterprise* (translated from the original German title).
However, it was Alfred Weber’s, *Theory of the Location of Industries* (1929), that brought the optimum location of a plant (or service organization, political or cultural system – Fearon, 2006) to prominence. According to Weber, the optimum location is defined as the location where a plant’s costs are minimized as a function of the location of a fixed market and the locations of the required raw resources (Blaug, 1985). The solution, which is based on the minimization of transportation and labor costs, considers three factors: 1) the costs associated with distance and the weight ratio of raw materials to finished products (*e.g.* in mining, transportation of the ore will be considerably more costly than transportation of the extracted product which would suggest location of the plant closer to the raw material), 2) labor costs, which can be used to offset transportation costs, and 3) the financial impacts of agglomeration (concentration of industries and resources) and deglomeration (dispersion) (Fearon, 2006).

Central Place Theory, considered by some to be “the single most powerful and influential theory to have developed in geography” (Golledge, 1996, p. 473), looks at the spatial hierarchies of markets, transportation, and administrative systems (Agarwal, 2006; Kershaw & Safford, 1998; Preston, 1983). Proposed by Walter Christaller in 1933 (Agarwal, 2006; Böventer, 1969), Central Place Theory sought to define a theoretical framework for the location of population centers (hamlets, villages, towns, cities) and institutions (Böventer, 1969) in the tradition of von Thünen’s Land Use Theory and Weber’s Industrial Location Theory (Berry & Harris, 1970). The three underlying concepts of Central Place Theory include: centrality – which refers to the draw of a particular location, threshold – which is the minimum radius of a market required to
support the initiation, and range - the maximum distance consumers are willing to travel to purchase goods or services (Agarwal, 2006; Krumme, 2000). The ultimate expression of Central Place Theory was the idea that in an idealized space the hierarchy of central places would exist as a series of nested hexagons where marketing areas were optimized. The goods and services available at the various levels of the hierarchy, and therefore their distribution across geographic space, are then a function of the centrality, threshold and range. One way to “visualize” this is to consider the higher educational hierarchy developed in California system with its variable catchment areas defined by the order of the institutions.

Finally, Spatial Competition and Competitive Differentiation, as defined by Harold Hotelling’s article (1929), is oriented toward defining the optimal response to locational competition (Krumme, 2000) or how to compete more effectively by changing locations. As with the theories briefly described above, Hotelling’s model is a generalization based on a number of assumptions. The meat of his theory, however, is that “some aspects of spatial competition may actually lead to the mutual attraction of sellers” (Hoover & Giarrantani, n.d., sect. 4.4, ¶6). Put another way, two competitors may find the optimum profit making location to be essentially adjacent at the center of their combined market (Hamilton, 1967; Hotelling, 1929). While the location of fast food restaurants are the classic example of this theory (by locating near each other, Burger King and MacDonald’s create a focal point for fast-food distribution that draws a greater population of potential customers than individual, isolated vendors), higher education in U.S. Metropolitan areas, where the top eight metro areas enroll 19 percent of the total
U.S. higher education population (Atlanta Regional Council for Higher Education, 2008), has been identified as having similar characteristics.

So why look at location theories and their associated models, whose purpose is to “explain the spatial distribution of production activities in an economy” (Thisse, 1987, p. 519), when seeking to understand the impact of online learning on the higher education enterprise? Many have stated that classic higher education should not and cannot truly function as a market driven enterprise to begin with (Chambers, 2005; Kirp, 2003). Yet, as indicated by others (Berg, 2002; Black, 2001; Bok, 2003; Finkelstein & Scholz, 2000; Kezar, 2005; Newman, Couturier & Scurry, 2004; Oberg, 1998), both the rising for-profit and traditional non-profit higher education sectors have grown to be multibillion dollar, market-based businesses. We can also see that at various scales, parts and portions of the higher education enterprise do conform to some of the defining concepts from the four classic location traditions.

For example, Schofer (1971, 1975) stated that the basic principles of Christaller’s Central Place Theory can be applied to the higher education enterprise. One piece of the “evidence” used to support the analogy is that students, one of the system components he defines, are generally distance minimizers. However, the friction coefficient associated with given distances can be reduced by the perceived quality of the product (or education, or institution). Yet it is not the students who determine where any given institution is located. That decision goes to another system component, the control groups. According to Schofer (1971), control groups make their higher education spatial decisions based on political and personal criteria. It is where the control groups spatial decision and students
(consumers) distance minimization behavior overlap that sustainable institutions have developed. Where it has not overlapped, an expected outcome when the locational decisions are not made in concert with the market based information; institutions (a lot of them) have failed. Kershaw and Safford (1998) also associate the structure of higher education to the idealized administrative structure described in Central Place Theory. While they too consider the consumers interest in minimizing the costs associated with overcoming distances, they focus more on identifying the similarities between the hierarchical order of services, defined catchment student/consumer areas, etc.

From the limited literature available on the topic, we might reasonably conclude that there is in fact some basis for explicitly relating higher education to classical geographic location theory. Where does that lead us to in terms of the development and impending proliferation of online education? Consider the thread that ties the four classic location theories together; distance. Each of the theories looks at how the costs associated with distance, or more correctly overcoming distances, impact location and purchasing decisions. The distance thread that is woven through each theory is the same thread those proponents of online education say can be cut because it is no longer relevant. The argument goes; that because the web, unlike all of the communication media previous, provides essentially costless scalability (it costs the same to send a digital burst, e-mail or other electronic communication, next door as it does to send it to the other side of the globe), consumers no longer have to consider the costs associated with overcoming distance and can make their decision based on the quality of the product or the appropriateness of the product to their need.
The premise underlying the development of online programs is clear and attractive. If the cost of delivering an education is fixed regardless of the distance to the student, then institutions can deliver their product anywhere (Kershaw & Stafford, 1998). And, since they can deliver anywhere, the potential market size is no longer restricted by politically or geographically defined spaces (cities, counties, states, regions, etc.) (Kershaw & Stafford, 1998; Kershaw, 1999). Philosophically, access to higher education becomes considerably more widespread (Moore & Kearsley, 2005) if not ubiquitous. Financially, the customer base available to institutions with online offerings is now the global population of post-secondary aged individuals (Figure 12). Unfortunately the reality is less rosy and the democratic ideal of the internet falls short (Warf, 2001). Two significant issues stand in the way of the “anytime, anywhere” online education rhetoric; physical access to the internet and financial ability to pay for the hardware and tuition required to participate (Kellerman, 2002).

While access to the internet has been growing at a dizzying pace, it is not yet near globally available (Warf, 2001). Simply stated, the wires do not yet go everywhere (Kellerman, 2002; Warf, 2001). Even within the United States there are significant disparities in availability or coverage gaps, particularly in rural areas (Grubesic & Murray, 2004; Grubesic & O’Kelly, 2002; Mills & Whitacre, 2003; National Telecommunication and Information Administration, 2004; Warf, 2001) (Figure 13). True, wires are not necessary to actually be “wired” to the cyber universe. However, the costs required to connect to the internet via satellite are prohibitive to the typically less
Figure 12: Global access to web based information and cost of transfer over time (United Nations Development Program, 2001).

affluent rural demographic (National Telecommunication and information Administration, 2004). Indeed, in some countries, where private satellite dishes are illegal, the costs could be particularly high (Warf, 2001). Once beyond the borders of this country and Europe, the diffusion of the infrastructure supporting access to the internet as well as the population’s ability to afford internet access decreases exponentially (United Nations Development Program, 1999, 2005; Warf, 2001). When considering the correlation between the global population distribution and the physical infrastructure supporting the web, it is apparent that world-wide access is still a remote goal (Warf, 2001; World Bank Group, 2002) (Figure 14).
Figure 13: Map of U.S. network connectivity as an expression of the number of bandwidth providers (Telegeography, 2004).

Going beyond the physical structure of the internet to the content provides an even deeper understanding of the obstacles that exist for institutions hoping to capitalize on the global market. Consider for instance that half of the people accessing information on the internet are in North America. Consider also that half of the people on the internet are viewing content served from North America (Moore & Kearsley, 2005). The implication is that there is relatively little cross-continental content viewing. Additionally, while the greatest proportion of web sites are served in the English language, that proportion is only 35.8% and falling (Moore & Kearsley, 2005). As further evidence of the current demographic limitations; internationally, internet usage appears to
be dominated by wealthy, young, males in urban environments (United Nations Development Program, 2001; Warf, 2001).

Figure 14: Distribution of the Internet around the world. (a) Worldwide router density map (b) Population density map (Yook, Jeong & Barabasi, 2002, p. 13383).

There is no question that the physical means to access the internet and information technology is expanding across the globe (Grubesic & O’Kelly, 2002; World Bank Group, 2002). However, once we pull back the curtain of “anytime, anywhere” it is equally clear that there is still a vast chasm to traverse before rhetoric has a chance of becoming reality (Gunkel, 2003). We must also remember that there is more preventing the realization of global access than the constraints of the infrastructure and culturally
based content (Warf, 2001). In regards to general access to information available through the internet as well as access to online higher education opportunities, recognition and acknowledgement of socioeconomic barriers has been growing (Mills & Whitacre, 2003; World Bank Group, 2002). We do not even have to navigate beyond the borders of the U.S. to examine the differences in educational opportunities that exist between the haves and have-nots.

The digital divide is what separates those individuals, households or institutions that have access to the latest technologies from those that do not (National Postsecondary Education Cooperative, 2004; World Bank Group, 2002). According to the National Telecommunication and Information Administration (2004), slightly over half of U.S households have internet access, and only 36% of those, or 20% of the total population, have broadband access (which is quickly becoming the requisite minimum to engage in online learning). That same study also indicates that the internet adoption rate in the U.S. appears to be slowing, thus it is possible that the proportion of the population able to participate in the cyber universe is approaching saturation. While there is no agreement regarding whether or not there is an actual or significant disparity between groups that leave some at a disadvantage (Booth, 2006; Gunkel, 2003; National Postsecondary Education Cooperative, 2004), there is some agreement that access is not evenly distributed throughout the population. So who are those without access?

The groups most frequently identified as having reduced access to the internet, whether due to lack of infrastructure, means, or relevance are rural inhabitants, those with lower incomes, black and Hispanic populations, those with lower levels of education, and
older individuals (Kvasny & Keil, 2006; Mills & Whitacre, 2003; National Postsecondary Education Cooperative, 2004; National Telecommunication and Information Administration, 2004). If in fact these populations are being left behind by the digital revolution, at least no new societal schisms are developing (Kvasny & Keil, 2006). On the other hand, it also signals that many of the existing social stratifications within the U.S. are being perpetuated if not magnified (Booth, 2006). The irony is that the unregulated technology heralded as being able to reduce barriers to education and socioeconomic mobility may actually be responsible for increasing the disparity between the so-call “haves” and have-nots”.

Chapter Summary

Although there has been little explicit analysis of the subject, it is clear that the locations of institutions of higher education since its inception in the United States in 1636 have not been a function of randomness. At various times and various scales individual institutions as well as systems of institutions have been consciously founded in specific locations for specific reasons. That is not to say that those reasons have borne fruit as successful locations, with “successful” being defined as able to foster the perpetuation of the institution. Many institutions have failed because the architects (in broad terms) responsible for their spatial location failed to take into account the fiscal realities associated with potential enrollment and the transportation costs of goods, services, and customers.
While the population traditionally available to participate in higher education in the U.S. has blossomed over time, the distribution has not been even across the landscape. Populations rise and fall in regions, states, and cities based on a number of complex and interacting variables. What has remained consistent so far has been the fact that the movement of individuals, or the extent of their “footloose” behavior, has been bound by the costs associated with overcoming distance. This idea is the cornerstone of location theory. Customers, or students in this context, are cost/distance minimizers and will purchase their goods (education) from the nearest resource, all other things being equal. In general this model has proven to be true.

As institutions have found their financial viability increasingly dependent on student tuition, thus continued if not increased enrollments, they have had to either differentiate themselves in some way (cost, reputation, program availability) gain a greater yield from their current market or increase the size of their market. While the entry of non-traditional students into the market has been a boon, the needs of those same students differ significantly from the traditional student base. Accordingly, institutions have had to figure out how to adjust their offerings to convert the potential new market to increased enrollments.

Theoretically, online education provides the ability for institutions to transcend space and time, two of the most significant cost variables beyond their control, and provide access to this burgeoning population that would otherwise be unable to participate in the personal enhancement process known as higher education. On the surface it seems a win-win situation for both institution and potential student. However,
the question remains, given the true constraints associated with online courses and programs, particularly as the number of institutions engaged in the activity increases and proliferates in the market (overall reducing each individual institution’s ability to differentiate itself), will the technology be able to overcome the multiple and inherent limitations of space to provide a new population of students to supplement campus enrollments, or will it simply provide an alternate means for students who might otherwise have registered for a campus course to engage with the institution on their own terms?
CHAPTER 3

METHODS

Introduction

The purpose of this comparative study was to differentiate student enrollments over an eight year period in on-campus and online courses offered through Montana State University. Geographic and demographic data will provide administrators with the information required to identify registration patterns (on-campus vs. online) and whether distinct student populations can be identified based on the mode of delivery. The design of this project used a comparative and spatially sensitive correlational approach (Getis, 2007) to identify differences in population demographics and associations between the spatial nature of campus based and online registrations over time. The population included all registrations (any individual could potentially register for multiple online or campus based courses thus be counted multiple times based on the multiple registrations) for on-campus and online courses offered by MSU from academic year 2000-2001 through 2007-2008.

The following research questions were addressed in this study: 1) Are there different home-of-origin geographic patterns between students taking courses at MSU through the on-campus registrar process and those taking online courses from MSU, 2) How do the home-of-origin geographic patterns compare and contrast over the eight year period, from 2000-2001 to 2007-2008, between the two groups, and 3) Is there a significant difference in the basic demographic characteristics (age and gender) of students registering for campus based and online courses over time? In regards to the
demographics, the question can more specifically be broken down into: 3.a. Are there significant differences in the mean ages of the on-campus and online student groups, 3.b. Have there been significant changes in the mean ages of the on-campus and online student groups over the specified time period, 3.c. Are there significant differences between the proportions of on-campus and online males and females for each year group, and finally, 3.d. How much of the changes in the proportions of males to females, if any exist, can be attributed to the year group and method of delivery over the eight year study period.

**Design & Rationale**

The first two research questions were addressed through an initial causal comparative “overview” assessment followed by more in-depth exploratory spatial data analysis (ESDA) to identify patterns of spatial autocorrelation within and between on-campus and fully online course registrations between academic years 2000-2001 and 2007-2008. Given that two of the concepts, distance education and funding models for public higher education institutions, underlying the first two research questions are indelibly linked to concept of space, and more specifically, location, exploration through the use of a geographic toolbox is appropriate and justified (Getis, 2007).

Spatial analysis and modeling has undergone a significant resurgence in the last couple of decades starting with the expanded use of Geographic Information Systems (GIS) (Montello & Sutton, 2006). Geographic Information Systems are computerized (hardware and software) means for storing, querying, manipulating and displaying data
geographically initially developed in the 1960’s (Montello & Sutton, 2006). However, it was the proliferation of low-cost, powerful desktop computers that brought GIS out of the labs and into broad commercial, non-profit and even personal use. That same increased access to personal computers and computational power fueled the development of spatially oriented statistical applications married to data visualization and GIS packages which has resulted in a burgeoning use of spatial data analysis tools (Anselin, 1999; Anselin et al., 2007). In the last decade spatial data analysis has become a fixture with the field of econometrics (Anselin, Florax & Rey, 2004), many of the social sciences (Goodchild, Anselin, Appelbaum & Harthorn, 2000) and a broad array of medical and health science investigations (Sridharan, Tunstall, Lawder & Mitchell, 2007).

Exploratory spatial data analysis is often considered a geographically oriented extension of exploratory data analysis (EDA) (Anselin, 1999; Sridharan et al., 2007). Whereas EDA is based on ad-hoc immersion, graphic representation and manipulation of data in order to interpret and analyze it (Montello & Sutton, 2006), the interpretation of the results from the underlying methods is still based on the assumption of case independence (Anselin, 1999; Bivand, 1998; Getis, 2007; Griffith, 1996a; Rogerson, 2006). ESDA is able to account for the incidence of spatial autocorrelation (the influence of proximity on correlation between variables), or the spatial lack of independence through the application of spatial weighting matrices (Anselin, 1999; Griffith, 1996a; Bivand, 1998). So it is through the integration of spatial weights that ESDA is able to “describe and visualize spatial distributions, identify atypical locations (spatial outliers), [and] discover patterns of spatial association (spatial clusters)” (Anselin, 1999, p. 258).
As Bivand (1998) states, “The literature on spatial statistics is substantial” (p. 3). To the researcher’s knowledge, this work was the first application of exploratory spatial data analysis within the higher education context.

The third research question was addressed using comparative and associational approaches to identify differences and trends in population demographics. Based on the volume of literature identifying online learners as generally being non-traditional though becoming more heterogeneous and reflecting adoption by more traditional students as well (Guernsey, 1998; Grubesic & Oliver, 2003; Moore & Kearsley, 2005; Palloff & Pratt, 2003; Roach, 2002; Wallace, 1996, 2002) it was appropriate to compare MSU’s online learners to their campus counterparts and also to see if there have been temporal shifts in the demographics that we might expect given the literature. Age is frequently evaluated with “standard” statistical tools (ANOVAs) to discern the probability that differences that may occur between samples exceed the differences that might be expected to occur do to random variation around the population mean. Gender, a dichotomous variable, can be assessed via logistic regression to determine whether and how much proportional changes may be associated with changes over the specified time period and mode of course delivery.

Pilot Study

The researcher conducted a pilot study in the summer of 2004. During the study an examination was made of 4,870 student registrations for distance delivered courses provided through the MSU Extended University (know as Extended Studies at that point) between the 2000 and 2003 academic years.
The age and gender of registrants were statistically described using one-way and factorial ANOVAs. A Chi Square test was then used to do a preliminary assessment of whether the proportion of registrations changed significantly by location over time. Finally, The GeoDa spatial statistics analysis package (Anselin, 2003d) was used to assess whether the location of registrants followed spatial patterns from academic years 2000 through 2003. GeoDa was used to compare the observed spatial pattern in a data set (e.g., clusters of registrants home of origin) to one in which space is irrelevant. GeoDa also allowed the computation of both the global Moran’s I statistic (Anselin, 2003a) for each year and the bivariate Local Indicator of Spatial Autocorrelation (LISA) (Anselin, 2003b) statistic for the four pairs of adjoining year groups from academic year 2000 to 2004. The null hypothesis for global Moran’s I was that there is no global spatial autocorrelation of the students within the areal unit defined as the U.S. The null hypothesis for the LISA statistic was that there were no statistically significant local spatial autocorrelation such as “hot spots” within the U.S.

The results of the pilot study indicated that there was a limited, but significant shift in the population demographics over the specified time period, with mean ages decreasing. Additionally, there were approximately one and a half times more women than men registered for those distance delivered courses. The Chi Square revealed that while registrations for the distance courses had increased for all three areal units studied (local, state and nation), the proportion of registrants from the local area increased at a statistically significant greater rate than the other two units. While the global Moran’s I statistic for the nation supported the null hypothesis for spatial autocorrelation, there was
a steady trend over the four year period toward increasing spatial autocorrelation at the national scale. The bivariate LISA cluster maps showed and supported at the zip code level the results of the Chi Square (i.e. the Bozeman area has been a disproportionate source of much of the growth in registrations for distance delivered courses), and the global Moran’s I (i.e. the transition from the checkerboard pattern in the 2000-2001 cluster map to the growing consolidation of the significant values in the northern plains region would be demonstrative of increasing national spatial autocorrelation).

The results of the pilot study identified significant demographic and spatial shifts in the population over the four year study period. However, the pilot only looked at registrations for distance delivered courses. In order to develop a more complete view of the institution, the resident population also needs to be studied to try and determine whether concurrent, divergent or static patterns exist.

**Research Context**

Montana State University is a land grant university located in Bozeman, Montana, and is home to eight colleges (College of Agriculture; College of Arts & Architecture; College of Business; College of Letters & Science; College of Education, Health & Human Development; College of Engineering; College of Nursing; and University College) and Extended University. It has a total part-time and full-time in-load headcount enrollment of 12,369: 10,188 undergraduate students, 646 post-baccalaureate students, and 1,535 degree seeking graduate students (MSU, 2008). During the fall semester of 2008 (MSU, 2008), the campus population was 47% female and 53% male. Resident, or
in-state students accounted for 63% of the total campus population with 33% out-of-state residents and 3% international students. Estimated annual tuition and fees for resident students for the 2007-2008 academic year was $5,749. For non-resident students tuition and fees were estimated to be $16,274.

The Extended University at Montana State University manages the delivery of the vast majority of the online courses offered by the university. The overwhelming bulk of the online courses were offered via the WebCT learning management system (LMS). However, beginning in the 2008-2009 academic year, the MSU system will transition to a new LMS and an extended pilot program involving the use of the open source Moodle LMS will continue. While Extended University is the official online course delivery manager for the institution there are instances of individual faculty members and units on campus delivering course content via Moodle, html, and some “home grown” systems via their own decentralized server resources. While over 842 WebCT shells were created for courses in the 2006-2007 academic year, the vast majority were supplements to campus based courses, with 181 delivered completely online (J. Pester, personal communication, November 15, 2007).

Under the 2005 revised Carnegie Classification System (Carnegie Foundation for the Advancement of Teaching, n.d.), the institution is classified as: Undergraduate Instructional Program - Professions plus arts & sciences, high graduate coexistence; Graduate Instructional Program - Doctoral, STEM (Science, Technology, Engineering, Mathematics) dominant; Enrollment Profile - Very high undergraduate; Undergraduate
Profile - Full-time four-year, selective, higher transfer-in; Size and Setting - Large four-year, primarily residential; Basic - Research Universities (very high research activity).

The city of Bozeman is frequently cited in various magazines as a desirable place to live: BizJournals – 2006 Top 10 Places to Live (1st Place), Skiing Magazine – 2004 Annual Top Ten Ski Towns (4th Place), Outside Magazine – 2003 Top 40 Best College Towns (5th Place). The population within the city limits is approximately 32,000 with 50,000 living within the “greater metropolitan area” of the Gallatin Valley and roughly 78,000 in the Gallatin County. Montana, also referred to as “The last best place”, has a 2005 estimated population of 935,670, ranking 44th in the nation. The average population density of the state, 6.2 persons per square mile is far below the national average of 79.6 (U.S. Census Bureau, n.d.) (Figure 15). According to the 2000 U.S. Census data, approximately 46% of Montana residents live in areas classified as rural.

Figure 15: Montana Population Density – 2000. (Montana Geographic Information Clearinghouse, n.d.).
Population

The population includes all registrations (any individual could potentially register for multiple online or campus based courses thus be counted multiple times based on the multiple registrations) for campus based and fully online courses offered at MSU from academic years 2000-2001 through 2007-2008. These years were chosen because they enclose the earliest year that a sizable number of online courses was available from MSU and the last complete academic year of data available.

Data Collection Procedure

The Office of Planning & Analysis and Extended University at MSU provided data for on-campus and online course registrations for the complete academic years of 2000-2001 to 2007-2008. An initial extract from the Montana University System’s Data Warehouse was provided by the Office of Planning & Analysis. While the registration data for on-campus courses seemed complete and consistent, the registration data for online courses was less so. Because registrations for online courses are accomplished through the Extended University using a separate registration system, not integrated with the Banner enterprise system used for all campus registrations, data integrity issues for the online registrations were identified. Specifically, many online courses and their registrations prior to the 2003-2004 academic year were absent from the Data Warehouse (Banner) extract. Additionally, the researcher found that early online registrations (2000-2002) were split between two separate databases as EU transitioned from the initial “legacy” system to the WebCT LMS. Eventually, registration data for the online courses
was woven together using the warehouse extract, online course lists from EU and the online course registration data used during the pilot study.

The data collected for analysis included the following elements for each course registration: the term code of the course offered (an amalgamation of the year and term), the last four digits of the student’s generated identification number (GID), the age of the student at the time of registration, the student’s birth date, their gender, their Local ZIP code, Away ZIP code, and Origin ZIP code, the Course Registration Number (CRN), Subject Code, Course Number, Section Number, and Delivery Mode code. Some of the data elements (GID, Birth Date, CRN, Subject Code, Course Number, Section Number) were used exclusively to establish and maintain referential data integrity. Courses and registrations were aggregated by the academic year (AY) they were offered in order to make the delivery mode and year-to-year demographic comparisons. ZIP codes were self reported during the registration process and were aggregated by AY for spatial analysis. The registrant’s gender was also used as part of the statistical analysis of the population demographics.

The three ZIP codes represent the following: 1) Origin ZIP – this is the ZIP code for the registrant’s home-of-origin which is “harvested” from their initial application to MSU and, by policy, is supposed to remain static and unaltered indefinitely; 2) Local ZIP – this ZIP code is the result of a script that runs when data is pulled from the Banner system into the Data Warehouse where the default is to populate the field first with the campus address, then the mailing address if there is no campus address, then the permanent address if there is no mailing address; 3) Away ZIP – this is also the result of a
scripting function during the warehouse data import where the selection process is reversed, pulling the permanent address first, then the mailing address if there is no permanent address. In many cases the early registration (2000-2003) data from Extended University had only the Origin ZIP attached. It should also be acknowledged that the Local and Away ZIP codes, while fixes once exported to the Data Warehouse, can be changed and self defined by the “owning” student at any time up until that point.

A very strict definition of online courses was used in the analysis of the data such that only those courses taught 100% online were considered “online” courses. In reviewing the course registration data it became evident that there was a considerable “grey area” associated with the definition of courses as online. In part, this was a function of the fact that the instructors self-identified whether the “shell” they were requesting was for a hybrid or online course. In many cases, courses were designated as online even thought students were required to attend classes on campus at various points throughout the semester. In other cases, lecture courses were designated as online but co-requisite labs were entirely campus based. So as not to skew the geographic analysis by identifying courses as online that forced geographic proximity to Bozeman by requiring students to physically attend synchronous meetings, the strict definition was imposed. Accordingly, individual faculty members, Program Assistants, and online course managers were contacted to verify whether or not individual courses were taught entirely at a distance or not.
Analysis

Unweighted Spatial Overview

A Chi Square test was be used to determine whether there were statistically significant differences in the proportionality of registrants over time from three aggregated groups of home-of-origin ZIP codes and by course delivery mode. Group 1, the “Bozeman Area”, included Belgrade, the three Bozeman ZIP codes, Gallatin Gateway, Livingston, Manhattan and Three Forks. Group 2, Montana, included all Montana ZIP codes except those included in Group 1. The third group, includes all other ZIP codes in the contiguous U.S. exclusive of those used in the other two groups.

Exploratory Spatial Data Analysis

The analysis of geo-referenced (spatially located) data required methodologies sensitive to the impact of spatial autocorrelation (Griffith, 1996a). GeoDa (Geographic Data Analysis), an exploratory spatial data analysis (ESDA) tool (Anselin et al., 2006), was used to assess whether the origin of registrants followed spatial patterns from academic years 2000-2001 through 2007-2008. Conceptually, GeoDa compared the observed spatial pattern in a data set (e.g., clusters of registrant’s home-of-origin) to one in which space was irrelevant or distributions were spatially random. GeoDa also computed both the bivariate global Moran’s I statistic (Anselin, 2003a; Anselin et al., 2006; Rogerson, 2006) and the bivariate Local Indicator of Spatial Autocorrelation (LISA) (Anselin, 1995; Anselin, 2003b; Anselin et al., 2006) for the seven pairs of adjoining year groups from academic year 2000-2001 to 2007-2008. Moran’s I measures general spatial autocorrelation for an areal unit (e.g. the U.S.) (Cliff & Ord, 1973;
Sridharam *et al.*, 2007; Rogerson, 2006). Moran’s $I$ is interpreted in a manner similar to correlation coefficients, with values near +1 considered to demonstrate strong spatial patterning (high values are near high values and low values are near low values), those near -1 having significant negative spatial patterns (high values are near low values) and values near zero indicative of a lack of spatial patterning (Rogerson, 2006). The null hypothesis of a Moran’s $I$ is that there is no global spatial autocorrelation, or that the homes of origin of the students are randomly distributed throughout the U.S.

The LISA statistic disaggregates the areal units of study (ZIP codes) from the “global” (U.S.) perspective of Moran’s $I$ to identify locally significant spatial clusters, or “hot spots”, and spatial outliers (Anselin, 1995; Rogerson, 2006; Sridharan *et al.*, 2007). The null hypothesis for the LISA statistic is that there are no statistically significant local spatial autocorrelation such as “hot spots” within the U.S. In one sense, the LISA statistic can be considered somewhat of a *post hoc* test for the global Moran’s $I$ in that the LISA can identify which of the individual units comprising the global areal unit contribute to the outcome of the Moran’s $I$ statistic. This can be the case whether the Moran’s $I$ is significantly positive, significantly negative or suggests randomness (because local clustering is either not strong enough to register globally or is negated by outliers) (Rogerson, 2006).

In order to define the LISA statistic for each ZIP code, a spatial weights matrix (Griffith, 1996b; Cliff & Ord, 1973; Rogerson, 2006) was defined (Anselin, 2003c, 2003d). Since the ZIP codes are represented by polygons rather than points, the contiguity weighting options, rather than the distance option, were appropriate. Two
contiguity options are available; the rook’s case contiguity (counts as contiguous polygons only those with adjoining sides) and the queen’s case contiguity (counts as contiguous polygons those with adjoining sides and those intersecting at vertices). The queen’s case was used as there was no reason to expect that there is a directional bias influencing the spatial autocorrelation (Cliff & Ord, 1973). Additionally, the non-uniform shape and areal extent of each ZIP code unit reduces the likelihood that the inclusion of polygons defined as adjoining based on intersecting vertices would significantly change the overall contiguity weighting in the analysis.

The bivariate LISA statistic was determined by comparing the first variable (x) of each ZIP code unit with the average of the second, spatially lagged, variable (y) from all of the contiguous ZIP code units. In other words, the 2000 – 2001 LISA statistic for Bozeman’s 59715 ZIP code was determined by comparing its value in 2000-2001 with the average values of all of the ZIP codes contiguous to 59715 in 2001-2002. The resulting statistic yields one of five possibilities for each ZIP code: 1) The designated ZIP code has a high value and is contiguous to other ZIP codes with an average high value, 2) The designated ZIP code has a low value and is contiguous to other ZIP codes with an average low value, 3) The designated ZIP code has a high value and is contiguous to other ZIP codes with an average low value, 4) The designated ZIP code has a low value and is contiguous to other ZIP codes with an average high value, and 5) The designated ZIP code has no significant interaction.

Significance for the first four interactions are displayed in an associated LISA significance map which is dynamically linked to each LISA cluster map. Statistical
significance, or “pseudo-significance”, was determined through a conditional permutation process (Anselin, 2003e; Anselin et al., 2006; McLaughlin & Boscoe, 2007; Sridharan et al., 2007). The user designated the number of permutations (9,999 in this study) whereby GeoDa fixed the value at a given areal unit and randomly assigned the other values to the remaining units generating a reference distribution for each permutation in order to determine the probability that observed differences are due to random variation.

The base ZIP code shapefile used in the GeoDa analysis was an Albers Equal Area projection derived from the 2006 ZIP code data set provided with ESRI’s ArcGIS software. The on-campus and online course registration data were appended to the database file associated with the ZIP code shapefile. Due to the nature of table joins, any ZIP codes in the registration data that were incorrect (typographical errors at the point of entry) or did not match the ZIP codes in the ESRI database were dropped from the join.

ZIP Codes as Areal Unit of Analysis

Defining the areal unit for a study, like making most methodological determinations, is a process of weighing pros and cons. Zone Improvement Plan (ZIP) codes were used in this study because the researcher believed they provided a level of spatial resolution where spatial hotspots could be identified and would be useful to university planners. From the geographic standpoint, aggregating the data by state would not have provided a clear or useful enough picture of the registration patterns (Griffith, 1996a). While county based data is more spatially refined than state level data, there are two associated limiting issues: 1) county of residence data is not collected with the same rigor as ZIP codes, resulting in extensive data gaps, and 2) counties, as politically defined
units, vary significantly in areal extent and population, making comparison problematic. Along those same lines, when one looks at a map of counties in the U.S. it is clear that states and regions within the country had very different methodologies for defining county boundaries that would make spatial comparisons suspect.

The use of ZIP codes is not without issues. Grubesic and Matisziw (2006) provide an extensive review of many of the issues associated with the use of ZIP codes in spatial analysis. Of primary concern is that ZIP codes do not actually define areas, they define points (buildings) and lines (streets). While generalized polygons (spatial areas) have been defined for ZIP codes, because ZIP codes are actually associated with roads (segments of which can transcend areal boundaries), it is possible for a residence with a given ZIP code to be included in the areal polygon of another ZIP code. As with counties, the size of ZIP codes also varies significantly because the postal service attempts to optimize ZIP code areas based on population allocation. On the positive side, this means that ZIP codes tend to have somewhat comparable populations. On the negative side, this means that the areal extents of specific ZIP codes are not stable over time. In other words, they are adjusted and split at irregular intervals resulting in spatiotemporal discontinuity (Grubesic & Matisziw, 2006).

Still, for the purposes of this study, the use of ZIP codes as the areal unit of analysis provided the optimum solution. Data gaps are minimal in the registration databases because ZIP codes are considered an essential part of mailing addresses (through which much initial and official institution/applicant information transactions occur). Additionally, ZIP code areas are generally small enough to provide good
resolution of spatial differentiation if it exists. Finally, from the practical outcome perspective, cost-conscious university planners already use ZIP code data to target locations where they believe they might be able to maximize their recruiting and enrollment efforts.

Demographic Analysis

The factorial Analysis of Variance (ANOVA) test was used to determine whether there was a significant difference in the mean ages of the registrants based on the academic years of registration, course delivery mode or any interaction effect between the two. The one-way ANOVA was used to determine whether there were differences from year-to-year between each group of registrants (on-campus and online). Finally, a logistic regression was used to identify how much of the changes, if there were any, in the proportions of males to females can be attributed to the year group and method of delivery over the eight year time period.

Chapter Summary

That the analysis of spatially referenced data is best accomplished using statistical techniques that account for spatial autocorrelation, which would violate the assumption of independence in standard statistical analyses, is well documented (Anselin, 1999; Bivand, 1998; Cliff & Ord, 1973; Goodchild et al., 2000; Rogerson, 2006). This research proposed to look at the spatial distribution of the home-of-origin of on-campus and online students enrolled at Montana State University for the academic years 2000-2001 to 2007-2008 to identify possible spatial trends or patterns through time and between modes of
course delivery. Additionally, basic demographics (age and gender) were assessed for the two populations over the specified time period to determine possible differences, trends, and significant characteristics that may prove useful to institutional planners. The exploratory spatial data analysis tool GeoDa was used to assess the spatial dimension of the research while factorial ANOVA, one-way ANOVA, and logistic regression were used to assess the demographic research questions.
CHAPTER 4

RESULTS

Introduction

The purpose of this comparative study was to identify student populations and registration patterns over an eight year period in on-campus and online courses offered by Montana State University. Whether or not distinct student populations could be identified based on the mode of course delivery (on-campus vs. online) was established through the analysis of spatial and demographic data. The design of this project used a comparative approach to identify differences in population demographics and a spatially sensitive correlational approach (Getis, 2007) to identify associations between the spatial nature of on-campus and online registrations over time. The population included all on-campus and online course registrations (any individual could potentially register for multiple online or on-campus courses thus be counted multiple times based on the multiple registrations) offered through MSU from academic year 2000-2001 through 2007-2008, inclusive of summer semesters.

The following research questions were addressed in this study: 1) Are there different home-of-origin geographic patterns between students taking courses at MSU through the on-campus registrar process and those taking online courses from MSU, 2) How do the home-of-origin geographic patterns compare and contrast over the eight year period, from 2000-2001 to 2007-2008, between the two groups, and 3) Is there a significant difference in the basic demographic characteristics (age and gender) of students registering for on-campus and online courses over time? In regards to the
demographics, the question was more specifically broken down into: 3.a. Are there significant differences in the mean ages of the on-campus and online student groups, 3.b. Have there been significant changes in the mean ages of the on-campus and online student groups over the specified time period, 3.c. Are there significant differences between the proportions of on-campus and online males and females for each year group, and finally, 3.d. How much of the changes, if there are any, in the proportions of males to females can be attributed to the year group and method of delivery over the eight year time period.

Foundations of Data Analysis

The first two research questions were addressed through Chi Square tests to provide an initial causal comparative “overview” assessment. This was followed by more in-depth spatial data analysis via Moran’s I, then bivariate and univariate LISA maps to identify patterns of spatial autocorrelation within and between on-campus and fully online course registrations. The third research question was addressed using comparative and associational approaches to identify differences and trends in the population demographics. The age variable was evaluated with both an ANOVA and Factorial ANOVA to discern whether differences that may occur between the populations exceed the differences that might be expected to occur due to random variation around the mean. Gender, a dichotomous variable, was assessed via logistic regression to determine whether and how much proportional changes may be associated with changes over the specified time period and mode of course delivery.
Results

Descriptive Data

Between summer semester 2000 and spring semester 2008, the combined total registrations for on-campus and online courses from Montana State University equaled 1,034,204. Of those registrations, 1,016,423 (98.28%) were in on-campus courses (to include hybrid and web-enabled, or enhanced, courses), while 17,781 (1.72%) were for entirely online courses. The distribution and trend by mode of course delivery from year to year is represented in Figure 16. Fall semesters had the greatest combined number of registrations with 505,600 (49.74%) over the entire eight year period, followed by spring with 461,087 registrations (45.36%), while the 49,763 summer registrations accounted for only 4.89% of the total. Online, the 7,563 fall registrations also accounted for the greatest proportion of total online course registrations during that time period (42.53%) with spring semesters providing the second greatest proportion of registrations with 6,332 (35.61%). Online registrations during the summer semesters made up 21.85% of the total count with 3,886.

By gender, registrations by males numbered 555,765 or 53.74% of the eight year total. Female registrations accounted for 477,774 or 46.20% of the total, and 665 (0.06%) had unreported gender. For on-campus courses, the gender distribution was 549,619 (54.07%) registrations by males, 466,399 (45.89%) registrations by females, and 405 (0.04%) registrations with no gender identified. Of the registrations for online courses, males accounted for 6,146 (34.56%), females for 11,375 (63.97%), and 260 (1.46%) had
no gender identified. It should be noted that MSU typically has a higher percentage of males than females in the student headcount as well (MSU, 2008).

Figure 16: On-Campus and Online Registrations by Academic Year.

Figure 17 provides a breakdown of the campus based registrations by year, semester and gender while the same breakdown for online courses can be seen in Figure 18. The campus based course registration patterns (Figure 17) demonstrate a relatively stable pattern over time with male registrations consistently higher than female registrations in the fall and spring semesters. During the summer, female registrations slightly outpaced male registrations, but that gap seems to have begun to decrease in the summers of 2006 and 2007. The online registration patterns (Figure 18) have been considerably more variable in amplitude. However, since the fall of 2001, with the exception of the spring 2003 semester, female registrations have consistently exceeded those by males across all semesters. It also appears that gender based registration patterns may have begun to develop with the online courses since the 2006-2007 academic year.
Figure 17: Campus Registrations by Academic Year, Semester & Gender.

Figure 18: Online Registrations by Academic Year, Semester & Gender.
Average ages for the on-campus and online populations also vary (Figure 19) with the overall mean for campus registrations being 33.04 years old and the mean age for on-campus registrations being 22.68 years old. Again, it should be noted that these are not the average ages of the students by headcount each academic year. The mean ages are weighted by the number of course registrations associated with each individual student. As with the number of registrations by gender, there is greater variability in the average age of the online registrations than there is for the campus based registrations, and while neither group shows a definitive trend toward getting older or younger, it is evident that the online registrants, on average, are consistently older than those associated with the on-campus registrations. More details regarding ranges and statistically significant differences will be provided later in the chapter in the Demographic Analysis section.

*Figure 19: Average Age for Registrations each Academic Year.*
Unweighted Spatial Overview

A Chi Square test was conducted to assess whether the proportion of registrations for distance delivered courses change significantly at three areal unit scales (local, state, and national) over time. The results of the test were significant for both the on-campus registrations, \( \chi^2 (14, N = 942,689) = 5836, p < .001, \) Cramer’s \( V = .056, \) and the online registrations, \( \chi^2 (14, N = 16,600) = 568.2, p < .001, \) Cramer’s \( V = .131, \) but had small effect sizes. While the on-campus registration counts for those students from the Bozeman area has seen fairly steady decline over the study period, the registration counts from elsewhere within the state showed a drop from 2000-2001 to 2001-2002 followed by a gradual increase cresting in the 2005-2006 academic year. The period from 2006 through 2008 saw declining registration counts for the rest of Montana as well as the Bozeman area. The other 47 contiguous states also witnessed a decrease in the registration counts between 2000-2001 and 2001-2002. However, since 2002, out-of-state registrations have increased steadily each year.

Registrations for online courses show greater variation than those found for on-campus courses. Online course registrations from the students with home-of-record in the Bozeman area increased steadily in the first three years of the study period, then declined somewhat from the 2003-2004 to 2005-2006 academic years and increased again from 2006 to 2008. For the rest of the state of Montana the online registration count has shown consistent increases through the entire study period. Registration counts from the other contiguous states increased from 2000 through the 2003-2004 academic year, declined
into 2005-2006, then rose slightly and plateaued the last two academic years of the study (Table 1).

The actual counts of Bozeman area registrations for on-campus courses were greater than the expected counts from 2000-2001 through 2003-2004. At that point, the expected counts, though generally decreasing, exceed the actual registration counts. For the rest of Montana, the expected count was greater than the actual count for the first two years of the study period. In 2002-2003, the actual count exceeded the expected counts and stayed above the expected count until the 2007-2008 academic year. The pattern for the remaining contiguous states is that the expected count exceeded the actual registration count from 2000 through 2003-2004. Starting in 2004-2005, the actual registration count was greater than expected counts, with the gap widening each year. For online course registrations from the Bozeman area, the expected and actual counts fluctuated back and forth but generally stayed close to each other. For the rest of Montana, expected online registration counts were greater than the actual counts for the first five years of the study period. Starting in 2005-2006 and through 2007-2008, the actual counts were greater than the expected counts. Out of state registrations for online courses showed the opposite pattern in that the expected count was less than the actual count from 2000-2001 through 2004-2005, then escalated above the actual registration count for the last three years of the study period (Table 1). Follow-up tests indicate that differences in changes between pairwise areal units over the study period were statistically significant, though with small magnitude effects, regardless of course delivery mode (Table 2).
<table>
<thead>
<tr>
<th>Course Mode</th>
<th>Areal Unit</th>
<th>00-01</th>
<th>01-02</th>
<th>02-03</th>
<th>03-04</th>
<th>04-05</th>
<th>05-06</th>
<th>06-07</th>
<th>07-08</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bozeman</strong></td>
<td><strong>Area</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>36,127</td>
<td>28,882</td>
<td>26,984</td>
<td>26,256</td>
<td>23,761</td>
<td>22,897</td>
<td>22,003</td>
<td>21,617</td>
<td></td>
<td>208,527</td>
</tr>
<tr>
<td>Expected</td>
<td>28,484.5</td>
<td>25,644.5</td>
<td>26,030.9</td>
<td>26,180.9</td>
<td>25,663.7</td>
<td>25,972.5</td>
<td>25,537.6</td>
<td>25,013.4</td>
<td></td>
<td>208,527</td>
</tr>
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<td><strong>Campus</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Count</td>
<td>61,312</td>
<td>58,307</td>
<td>59,932</td>
<td>60,866</td>
<td>60,379</td>
<td>61,264</td>
<td>59,192</td>
<td>56,819</td>
<td></td>
<td>478,071</td>
</tr>
<tr>
<td>Expected</td>
<td>65,303.8</td>
<td>58,792.7</td>
<td>59,676.7</td>
<td>60,022.5</td>
<td>58,836.8</td>
<td>59,544.8</td>
<td>58,547.8</td>
<td>57,345.9</td>
<td></td>
<td>478,071</td>
</tr>
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<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>31,331</td>
<td>28,742</td>
<td>30,758</td>
<td>31,234</td>
<td>31,878</td>
<td>33,253</td>
<td>34,253</td>
<td>34,642</td>
<td></td>
<td>256,091</td>
</tr>
<tr>
<td>Expected</td>
<td>34,981.7</td>
<td>31,493.8</td>
<td>31,967.3</td>
<td>32,152.6</td>
<td>31,517.5</td>
<td>31,896.7</td>
<td>31,362.6</td>
<td>30,718.8</td>
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<td>256,091</td>
</tr>
<tr>
<td><strong>Bozeman</strong></td>
<td><strong>Area</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Count</td>
<td>32</td>
<td>171</td>
<td>317</td>
<td>313</td>
<td>286</td>
<td>271</td>
<td>290</td>
<td>382</td>
<td></td>
<td>2,062</td>
</tr>
<tr>
<td>Expected</td>
<td>61.6</td>
<td>156.8</td>
<td>272.2</td>
<td>309.1</td>
<td>297.4</td>
<td>283.1</td>
<td>327.7</td>
<td>354.3</td>
<td></td>
<td>2,062</td>
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<tr>
<td><strong>Montana</strong></td>
<td><strong>Online</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>98</td>
<td>347</td>
<td>787</td>
<td>788</td>
<td>915</td>
<td>1,067</td>
<td>1,324</td>
<td>1,354</td>
<td></td>
<td>6,680</td>
</tr>
<tr>
<td>Expected</td>
<td>199.6</td>
<td>507.8</td>
<td>881.7</td>
<td>1,001.2</td>
<td>963.4</td>
<td>917.1</td>
<td>1,061.6</td>
<td>1,147.7</td>
<td></td>
<td>6,680</td>
</tr>
<tr>
<td><strong>US</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>366</td>
<td>744</td>
<td>1,087</td>
<td>1,387</td>
<td>1,193</td>
<td>941</td>
<td>1,024</td>
<td>1,116</td>
<td></td>
<td>7,858</td>
</tr>
<tr>
<td>Expected</td>
<td>234.8</td>
<td>597.4</td>
<td>1,037.2</td>
<td>1,177.8</td>
<td>1,133.3</td>
<td>1,078.8</td>
<td>1,248.8</td>
<td>1,350.1</td>
<td></td>
<td>7,858</td>
</tr>
</tbody>
</table>
Table 2

Pairwise Comparisons of Differences in Changes Between Areal Units by Delivery Mode.

<table>
<thead>
<tr>
<th>Course Mode</th>
<th>Comparison</th>
<th>Pearson $\chi^2$</th>
<th>p-value</th>
<th>Significance</th>
<th>Cramer’s V</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Campus</strong></td>
<td>Bozeman Area - MT</td>
<td>3,689</td>
<td>.000</td>
<td>*</td>
<td>.073</td>
</tr>
<tr>
<td></td>
<td>Bozeman Area – U.S.</td>
<td>4,979</td>
<td>.000</td>
<td>*</td>
<td>.104</td>
</tr>
<tr>
<td></td>
<td>MT – U.S.</td>
<td>753.1</td>
<td>.000</td>
<td>*</td>
<td>.032</td>
</tr>
<tr>
<td><strong>Online</strong></td>
<td>Bozeman Area - MT</td>
<td>94.99</td>
<td>.000</td>
<td>*</td>
<td>.104</td>
</tr>
<tr>
<td></td>
<td>Bozeman Area – U.S.</td>
<td>75.52</td>
<td>.000</td>
<td>*</td>
<td>.087</td>
</tr>
<tr>
<td></td>
<td>MT – U.S.</td>
<td>526.1</td>
<td>.000</td>
<td>*</td>
<td>.190</td>
</tr>
</tbody>
</table>

**Note.** * = significance.

Another way to view the results of the Chi Square analysis is by viewing the changes in the percentage of registrations for each mode of course delivery by each areal unit over the eight year time span (Figures 20 and 21). While from a geographic perspective it makes sense to investigate the three scale-associated areal units, from the perspective of higher education administrators, it is unnecessary to differentiate between local and in-state registrations. The significant differentiation for tuition and state funding purposes is between in-state and out-of-state students. Accordingly, a fourth areal unit was added which combines the Bozeman Area registrations with the rest of Montana to form a “Montana (All)” category. For on-campus courses, the relative proportion of out-of-state registrations have clearly and steadily increased (Figure 20). Over the same time period the percentage of registrations by local (Bozeman Area) students have been in decline. Across the rest of Montana, the relative proportion of on-campus registrations
Figure 20: On-Campus Registrations - % within Academic Year.

Figure 21: Online Registrations - % within Academic Year.
waxed from 2000-2001 to 2005-2006 and then waned the last two years. From the higher education administration perspective, the picture for the state comes into focus when the Montana registration data is aggregated into one statewide areal unit, “Montana (All)”. It is then that a steady decline in the relative proportion of in-state registrations for on-campus courses over the eight year study period is observed.

The trends for registration in online courses are less consistent than for the on-campus courses but recognizable nonetheless (Figure 20). Over the period of time studied, the percentage of registrations in online courses by out of state students declined by 47%. Conversely, the proportion of registration from within the state increased 132%. While a reasonable proportion (12.4%) of the total online registrations has come from Bozeman area registrations, and a greater percentage (13.4%) came in 2007-2008 than in 2000-2001 (6.5%), no consistent trend exists across the entire study period.

Exploratory Spatial Data Analysis

Univariate Moran’s *I*, which measures the general spatial autocorrelation for an areal unit (Cliff & Ord, 1973; Sridharam *et al.*, 2007; Rogerson, 2006), were calculated for the total registrations for on-campus and online courses over the eight year study period (Table 3). For the study period, the Moran’s *I* was slightly higher for the online registrations than for the campus registrations reflecting a marginally greater spatial autocorrelation for online registrations when viewing the entire lower 48 states as a single areal unit. This indicates that across the contiguous 48 states, online registrations have a slightly more consistent distribution pattern where high values tend to be located near
other high values and low values tend to be near other low values, as opposed to high
values being near low values and the converse.

Table 3

*Univariate Moran’s I for Registrants in the U.S.: Total (p-value in parenthesis).*

<table>
<thead>
<tr>
<th>Course Mode</th>
<th>2000-2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus</td>
<td>0.332 (0.001)</td>
</tr>
<tr>
<td>Online</td>
<td>0.357 (0.001)</td>
</tr>
</tbody>
</table>

Cartograms were prepared to assist in the visualization of the distribution of
course registrations over the “global” areal unit (the lower 48 states) through the eight
year study period. Conventional maps, through various projections, offer adequate
representations of the relative locations, distances, and sizes of geographic units.
However, the value of the variables associated with those areal units can sometimes be
misrepresented or overlooked completely when the spatial unit is either diminutive or
relatively large. Cartograms overcome that weakness by representing, through size and/or
color, the areal units proportional to the value of the variable within that space at the
expense of providing accurate spatial representation (Anselin, 2005). Accordingly, the
color (upper outliers are red) and size of the circles in Figure 22 represent the relative
number of course registrations in on-campus courses at the ZIP codes across the study
area. Figure 23 provides the same type visualization for online course registrations.

The bivariate global Moran’s *I* statistic was calculated to determine the spatial
autocorrelation of the MSU on-campus and online course registrants within the
contiguous Unites States from year to year (Table 4). This process, completed within the
Figure 22: Cartogram of Campus Registrations 2000-2008 (n=942,689).

Figure 23: Cartogram of Online Registrations 2000-2008 (n=16,600).
GeoDa program with a pre-defined significance level of 0.05, regressed the ZIP code in year 1 with the neighboring/contiguous ZIP codes averaged year 2 values (the spatially lagged variable). This bivariate approach provides a “space-time” perspective of the spatial correlation by comparing the same variable (registration counts in ZIP codes) at different points in time. Regressing the average value of the neighbors in the future against the present value of the central ZIP code provides an outward diffusion perspective (from core to neighbors) (Anselin, 2005). While none of the AY registrations yielded even medium strength Moran Global $I$ statistics (Table 4), there is a steady trend in a positive, upward direction from year to year for on-campus course registrations. This means that higher (or lower) registrations in a given ZIP code one year are increasingly over time associated with higher (or lower) registrations in the neighboring ZIP codes. The same general trend applies to the Moran’s $I$ for online registrations.

Table 4

<table>
<thead>
<tr>
<th>Course Mode</th>
<th>00-01</th>
<th>01-02</th>
<th>02-03</th>
<th>03-04</th>
<th>04-05</th>
<th>05-06</th>
<th>06-07</th>
<th>07-08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus</td>
<td>0.279</td>
<td>0.315</td>
<td>0.330</td>
<td>0.345</td>
<td>0.354</td>
<td>0.361</td>
<td>0.371</td>
<td></td>
</tr>
<tr>
<td>Online</td>
<td>0.117</td>
<td>0.305</td>
<td>0.312</td>
<td>0.336</td>
<td>0.328</td>
<td>0.344</td>
<td>0.335</td>
<td></td>
</tr>
</tbody>
</table>

Bivariate Local Indicators of Spatial Analysis (LISA) cluster and significance maps were run for the campus (Figures 26-39) and online course registrations (Figures 40-53). The LISA maps identify whether and where the global Moran’s $I$ can be disaggregated into local clusters or hotspots. As with the bivariate Moran’s $I$, the
bivariate LISA allows the identification of outward diffusion, from the core ZIP code in a
given year to its neighbors the following year, but “drills down” into the global areal unit
to identify if and how local clusters have developed and/or changed over time. When
viewing the cluster maps it is important to understand that only the cluster center is
identified with a color. The color of a given ZIP code polygon represents a statistically
significant association between the number of course registrations at that central
(colored) ZIP code (x variable) and the average value of the course registrations for the
ZIP codes contiguous to the central ZIP code in the following year (the y, or spatially
lagged, variable). As noted earlier, there are five possible outcomes for each areal unit
(ZIP code) represented on the LISA cluster maps (Figure 24) with the associated pseudo
$p$-value (Figure 25) identified on the significance maps:

- Not Significant
- High – High: A high number of course registrations in a ZIP code surrounded by
  neighbors with an average high number of course registrations the following year.
- Low – Low: A ZIP code with a low number of course registrations surrounded by
  neighboring ZIP codes with an average low number of registrations the following
  year.
- Low – High: A low number of course registrations from a ZIP code with
  neighboring ZIP codes that have an average high number of registrations the
  following year.
- High – Low: A high number of course registrations from a ZIP code surrounded
  by neighbors with an average low number of course registrations the following
  year.
The following pages show bivariate LISA cluster maps paired with their associated significance map. The cluster maps identify significant clusters by type (Figure 24), and the significance maps identify the level of significance of the identified clusters (Figure 25). Each page represents one bivariate (variable x compared to the spatially lagged variable y) cluster analysis. Figures 26 through 39 show the space-time progression (starting with x = 2000-2001, y = 2001-2002) of campus registrations. Figures 40 through 53 show the space-time progression of online registrations beginning with the 2000-2001 and 2001-2002 pair.
Figure 26: Bivariate LISA Cluster Map - Campus Registrations 2000-2001 w/ 2001-2002 Neighbors.

Figure 27: Bivariate LISA Significance Map - Campus Registrations 2000-2001 w/ 2001-2002 Neighbors.
Figure 28: Bivariate LISA Cluster Map - Campus Registrations 2001-2002 w/ 2002-2003 Neighbors.

Figure 29: Bivariate LISA Significance Map - Campus Registrations 2001-2002 w/ 2002-2003 Neighbors.
Figure 30: Bivariate LISA Cluster Map - Campus Registrations 2002-2003 w/ 2003-2004 Neighbors.

Figure 31: Bivariate LISA Significance Map - Campus Registrations 2002-2003 w/ 2003-2004 Neighbors.
Figure 32: Bivariate LISA Cluster Map - Campus Registrations 2003-2004 w/ 2004-2005 Neighbors.

Figure 33: Bivariate LISA Significance Map – Campus Registrations 2003-2004 w/ 2004-2005 Neighbors.
Figure 34: Bivariate LISA Cluster Map - Campus Registrations 2004-2005 w/ 2005-2006 Neighbors.

Figure 35: Bivariate LISA Significance Map - Campus Registrations 2004-2005 w/ 2005-2006 Neighbors.
Figure 36: Bivariate LISA Cluster Map - Campus Registrations 2005-2006 w/ 2006-2007 Neighbors.

Figure 37: Bivariate LISA Significance Map - Campus Registrations 2005-2006 w/ 2006-2007 Neighbors.
Figure 38: Bivariate LISA Cluster Map - Campus Registrations 2006-2007 w/ 2007-2008 Neighbors.

Figure 39: Bivariate LISA Significance Map - Campus Registrations 2006-2007 w/ 2007-2008 Neighbors.
Figure 40: Bivariate LISA Cluster Map - Online Registrations 2000-2001 w/ 2001-2002 Neighbors.

Figure 41: Bivariate LISA Significance Map - Online Registrations 2000-2001 w/ 2001-2002 Neighbors.
Figure 42: Bivariate LISA Cluster Map - Online Registrations 2001-2002 w/ 2002-2003 Neighbors.

Figure 43: Bivariate LISA Significance Map - Online Registrations 2001-2002 w/ 2002-2003 Neighbors.
Figure 44: Bivariate LISA Cluster Map - Online Registrations 2002-2003 w/ 2003-2004 Neighbors.

Figure 45: Bivariate LISA Significance Map - Online Registrations 2002-2003 w/ 2003-2004 Neighbors.
Figure 46: Bivariate LISA Cluster Map - Online Registrations 2003-2004 w/ 2004-2005 Neighbors.

Figure 47: Bivariate LISA Significance Map - Online Registrations 2003-2004 w/ 2004-2005 Neighbors.
Figure 48: Bivariate LISA Cluster Map - Online Registrations 2004-2005 w/ 2005-2006 Neighbors.

Figure 49: Bivariate LISA Significance Map - Online Registrations 2004-2005 w/ 2005-2006 Neighbors.
Figure 50: Bivariate LISA Cluster Map - Online Registrations 2005-2006 w/ 2006-2007 Neighbors.

Figure 51: Bivariate LISA Significance Map - Online Registrations 2005-2006 w/ 2006-2007 Neighbors.
Figure 52: Bivariate LISA Cluster Map - Online Registrations 2006-2007 w/ 2007-2008 Neighbors.

Figure 53: Bivariate LISA Significance Map - Online Registrations 2006-2007 w/ 2007-2008 Neighbors.
The bivariate LISA maps for the on-campus course registrations (Figures 26-39) show little variation through the study period (displayed in a time progression series in Figure 54) around what can be considered the core of Montana State University’s on-campus geographic student recruitment “footprint”; Montana and the adjacent peripheries of the contiguous states. Beside the “core”, areas that seem to hold fairly steady with High-High ZIP codes include: the Minneapolis-St. Paul area; the Rocky Mountain “Front Range” area from Colorado Springs, up through Fort Collins and into Cheyenne and Laramie, WY; the area from Gunnison, through Crested Butte to Aspen in CO; Bismark, ND; Spokane, the Puget Sound region, and from Bellingham north to the Canadian border in WA; the Salt Lake City area; the I-90 (Coeur d’Alene) and I-15 corridors (Idaho Falls, Pocatello, Boise) through ID; the Bend and Portland areas in OR; the Rapid City and Black hills area of SD; and to a lesser, but consistent geographic extent, Duluth, MN; Fargo, ND; and Sioux Falls, SD. Less persistent through the entire study period, but continuously developing and expanding since the 2004-2005 academic year are the High-High ZIP code clusters in the Burlington, VT area.

*Figure 54:* Bivariate LISA – On-Campus Course Registrations 2000-2001 to 2007-2008.
When comparing the cluster maps of the online and on-campus course registrations it needs to be understood that the cluster type designations (High-High, High-Low, Low-Low, and Low-High) are based on a relative scale. For example, on the bivariate cluster map for 2000-2001 with neighboring 2001-2002 online registrations (Figure 40), the Woodstock, IL, ZIP Code is identified as the center of a High-High cluster with only three registrations in 2000-2001.

For the online course registrations (Figures 40-53), the spatial variability over the eight year study period (Figure 55) was considerably greater than that found in the on-campus registrations. Though initially scattered, High-High ZIP code clusters included the greater Gallatin Valley area (Livingston, Bozeman, Belgrade, Three Forks, Manhatten), Butte, Dillon, Helena, the Billings area, Havre, Missoula, Polson, Kalispell, Whitefish, and Eureka, MT. Outside of Montana, the early (2000-2001) High-High clusters included the Bend, OR area, and the Casper, WY area (Figure 40). There was also a preponderance of Low-Low clusters distributed across the lower 48 states in the 2000-2001 with 2001-2002 neighbors bivariate LISA map (Figure 40). However, by the second bivariate LISA cluster map (Figure 42) the vast majority of those Low-Low clusters disappear and more High-High clusters form in the same core region as the on-campus courses by the third year of the analysis (Figure 44). By 2003-2004 / 2004-2005 (Figure 46) some of the more peripheral High-High clusters found on the campus LISA maps are being duplicated on the online cluster maps. However, the remainder of the online bivariate LISA maps display a mix of High-High clusters and spatial outliers.
(High-Low and Low-High ZIP codes) filling out the core area with High-High and Low-Low clusters popping up, then disappearing within one to three year time spans.

**Figure 55**: Bivariate LISA - Online Course Registrations 2000-2001 to 2007-2008.

Another way to compare the spatial similarities or differences between the online and on-campus clusters over the eight year time period is to compare the cluster types directly. One way to do this is to match online registration ZIP codes to on-campus registration ZIP codes across the study area (n = 29,801) to identify the percentage in any given year that have identical cluster designations. Unfortunately, there is a known bug in GeoDa that prevents saving bivariate LISA cluster types into the data table correctly. As a proxy, univariate LISA clusters were derived for each academic year by mode of course delivery. Using the on-campus LISA clusters as the base for each univariate year analysis, the percentage of matching online cluster types by ZIP code was calculated. What we see across the spatial extent is generally an increase in the percentage of direct ZIP code to ZIP code cluster matching over the study period (Figure 56). Note that Low-Low clusters are not identified; this is because there were too few or none for the campus LISA analysis for constructive comparisons to be made.
Figure 56: ZIP Code Matching by Cluster Type.

Extracting the data for the Montana ZIP codes provided the opportunity for additional comparison by refining the spatial scale to look at the “core” of MSU’s spatial registration area. This time, rather than matching ZIP code to ZIP code, the percentage of all Montana ZIP codes (n = 320) was calculated for each LISA cluster type, by course delivery mode, and for each academic year (Figure 57). As with the ZIP code matching above, this analysis was based on univariate LISA cluster data. Across each year for registrations in on-campus courses, between 84% and 87% of the ZIP Codes in Montana are identified as High-High clusters. For online courses, after the first two years where only 4.39% and 25.63% of the ZIP codes in Montana had sufficient registrations to be classified as High-High clusters, the percentage has fluctuated around the low to mid
40% mark. Although it is generally the case, it should not be assumed that the same ZIP codes maintain the same cluster type designation from year to year.

Figure 57: Percent of ZIP Codes by Cluster Type in Montana.

Another way to view the spatial registration footprints of MSU’s on-campus and online course registrations is to agglomerate them over the entire study period and view them as univariate LISA maps. This provides a more static representation of the spatial clusters and outliers for each course delivery mode. The LISA cluster map (Figure 58) and associated significance map (Figure 59) for on-campus course registrations for the eight year study period display essentially the same High-High clusters and a slight reduction in the Low-High outliers at the periphery that one would expect given that there was limited fluctuation in the on-campus series of bivariate LISA maps. The univariate LISA cluster map (Figure 60) and its associated significance map (Figure 61) for the
**Figure 58:** Univariate LISA Cluster Map - Campus Registrations 2000-2008 (n=942,689).

**Figure 59:** Univariate LISA Significance Map - Campus Registrations 2000-2008 (n=942,689).
Figure 60: Univariate LISA Cluster Map - Online Registrations 2000-2008 (n=16,600).

Figure 61: Univariate LISA Significance Map - Online Registrations 2000-2008 (n=16,600).
online course registrations yields a larger core overlay with the univariate on-campus LISA maps with fewer Low-High outliers. The univariate LISA map of online registrations also stabilizes (in “time” – because it is a comprehensive snapshot for the entire study period) some of the spatially distributed High-High clusters that fit within the on-campus registration High-High clusters (Denver, CO, Minneapolis-St. Paul, MN, Boise, ID, Bend, OR, etc.). The univariate LISA maps also “stabilize” a few unique High-High clusters like Duluth area in Minnesota, the Durango, CO area, the Camp Pendleton area between San Diego and Los Angeles, Keams Canyon, AZ, Zuni, NM, and several ZIP codes to the north of Chicago, IL that are somewhat more ephemeral in the year-to-year bivariate analyses.

Demographic Analysis

A 2x8 factorial Analysis of Variance (ANOVA) was conducted to evaluate whether there is a difference between the mean ages of the registrants based on the academic year of registration, the course delivery mode, or an interaction between the academic year and course delivery mode. The first independent variable, academic year, consisted of the eight academic years previously identified. The second independent variable was the course delivery mode; on-campus or online. The dependant variable was the ages of the individuals registering for courses at MSU over the study period. The means and standard deviations for the ages of the registrants as a function of the two factors are presented in Table 5. The ANOVA indicated that the main effect of Delivery Mode was highly significant with a small to medium effect size ($F(1, 1034020) = 41725.027, p = .000, \eta^2 = .039$). The main effect of Academic Year ($F(7, 1034020) =$
82.986, \( p = .000, \eta^2 = .0005 \)) and the interaction effect \((F(7, 1034020) = 94.646, \ p = .000, \ \eta^2 = .0006)\) were also statistically significant though both had very small to negligible effect sizes. A pairwise comparison of the course delivery mode of the registrants indicates that the students registered for on-campus courses were significantly younger than those registered for online courses \((p = .000)\) during the academic years they were registered. Pairwise comparisons of the academic year were also statistically significant, but given the almost insignificant \(\eta^2\) (Eta squared) associated with that variable, and the fact that variation in age for the total (on-campus and online) population does not relate to any of the questions of concern for this study, those results will not be developed in detail. It should also be noted that Levene’s Test of Equality of Error Variance indicated that the assumption of equal variance was violated \((p = .001)\).

A one-way analysis of variance (ANOVA) was conducted for each group of registrants (on-campus and online) to evaluate whether there is a difference between their mean ages from academic year to academic year. The independent variable for both ANOVAs consisted of eight academic years: 2000-2001, 2001-2002, 2002-2003, 2003-2004, 2004-2005, 2005-2006, 2006-2007, and 2007-2008. The dependent variable was the ages associated with each registration (in either course delivery mode) during those years. The ANOVA for registrations of on-campus courses was significant \((F(7, 1016293) = 151.425, \ p = .000, \ \eta^2 = .001)\) as was the ANOVA for registrations of online courses \((F(7, 17692) = 23.390, \ p = .000, \ \eta^2 = .009)\). This indicated that for both modes of course delivery there were statistically significant mean ages associated with registrations in the different academic years. The strength of the relationship between the
type of AY and the ages of the registrants, as assessed by $\eta^2$, was essentially insignificant. The power for both ANOVA tests was found to be 1.00 indicating that the probability of making a Type II error was zero percent.

Table 5

*Means and Standard Deviations for Ages of Registrants.*

<table>
<thead>
<tr>
<th>Course Delivery Mode</th>
<th>Academic Year</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online</td>
<td>2000-2001</td>
<td>38.35</td>
<td>8.73</td>
</tr>
<tr>
<td></td>
<td>2001-2002</td>
<td>32.34</td>
<td>12.63</td>
</tr>
<tr>
<td></td>
<td>2002-2003</td>
<td>32.60</td>
<td>12.41</td>
</tr>
<tr>
<td></td>
<td>2003-2004</td>
<td>32.31</td>
<td>11.79</td>
</tr>
<tr>
<td></td>
<td>2004-2005</td>
<td>32.32</td>
<td>11.60</td>
</tr>
<tr>
<td></td>
<td>2005-2006</td>
<td>34.21</td>
<td>11.22</td>
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<tr>
<td></td>
<td>2006-2007</td>
<td>33.18</td>
<td>10.89</td>
</tr>
<tr>
<td></td>
<td>2007-2008</td>
<td>32.97</td>
<td>11.00</td>
</tr>
<tr>
<td>Campus</td>
<td>2000-2001</td>
<td>22.78</td>
<td>5.95</td>
</tr>
<tr>
<td></td>
<td>2001-2002</td>
<td>22.70</td>
<td>5.75</td>
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<tr>
<td></td>
<td>2002-2003</td>
<td>23.06</td>
<td>5.96</td>
</tr>
<tr>
<td></td>
<td>2003-2004</td>
<td>22.78</td>
<td>6.05</td>
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<tr>
<td></td>
<td>2004-2005</td>
<td>22.64</td>
<td>5.94</td>
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<tr>
<td></td>
<td>2005-2006</td>
<td>22.51</td>
<td>5.76</td>
</tr>
<tr>
<td></td>
<td>2006-2007</td>
<td>22.52</td>
<td>5.79</td>
</tr>
<tr>
<td></td>
<td>2007-2008</td>
<td>22.42</td>
<td>5.55</td>
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</tbody>
</table>

The Tukey HSD post hoc test procedure was conducted to control for Type I error rates when making pairwise comparisons among the eight groups of means. The results of the test for campus registrants are reported in Table 6 while the results for online
registrants are in Table 7. Means and standard deviations were previously reported in Table 5. Almost all years of on-campus registrations were found to be statistically different from each other. For the online registrations, year 2000-2001 and 2005-2006 were statistically different from all other year groups, but were not statistically different from each other.

Table 6

*Differences Among Academic Years on Age of Campus Registrants.*

<table>
<thead>
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<tbody>
<tr>
<td>2000-2001</td>
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<tr>
<td>2001-2002</td>
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<tr>
<td>2002-2003</td>
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<tr>
<td>2003-2004</td>
<td>NS</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
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<td>2004-2005</td>
<td>*</td>
<td>NS</td>
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<td>2005-2006</td>
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<tr>
<td>2006-2007</td>
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<td>*</td>
<td>*</td>
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<td>2007-2008</td>
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<td>*</td>
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<td>*</td>
</tr>
</tbody>
</table>

*Note.* NS = nonsignificant differences between pairs of means, while an asterisk (*) = significance using the Tukey HSD procedure.
Table 7

Differences Among Academic Years on Age of Online Registrants.

<table>
<thead>
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<tr>
<td>2002-2003</td>
<td>*</td>
<td>NS</td>
<td></td>
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<td></td>
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<tr>
<td>2003-2004</td>
<td>*</td>
<td>NS</td>
<td>NS</td>
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<tr>
<td>2004-2005</td>
<td>*</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
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<td>2005-2006</td>
<td>*</td>
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<td>*</td>
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<tr>
<td>2006-2007</td>
<td>*</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
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</tr>
<tr>
<td>2007-2008</td>
<td>*</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>*</td>
<td>NS</td>
</tr>
</tbody>
</table>

Note. NS = nonsignificant differences between pairs of means, while an asterisk (*) = significance using the Tukey HSD procedure.

A forward conditional logistic regression was used to predict gender of registrants from the mode of course delivery and the academic year registered. Both independent variables were significant predictors of the gender of a registration. However, the mode of course delivery was a much stronger predictor of the gender associated with a course registration than the academic year associated with the registration. The odds of an on-campus course registration are 0.46 times the odds of an online course registration being from a female (Table 8). From a different perspective, on-campus course registrations are 2.18 times the odds of online registrations to be from a male. The Hosmer and Lemeshow Test significance of 0.319 indicates that the logistic regression model is a good fit for the data. The associated $R^2$ statistic, unchanged from Step 1 to Step 2 (Cox & Snell = .002,
Nagelkerke = .003), indicates that minimal variance in the gender is accounted for by the predictors.

Table 8

Summary of Forward Stepwise Logistic Regression for Variables predicting Gender of Registrant (N = 1,033,539).

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>Cox &amp; Snell R²</th>
<th>Nagelkerke R²</th>
</tr>
</thead>
<tbody>
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<td></td>
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<tr>
<td>Delivery Mode</td>
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<td>.016</td>
<td>.458</td>
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<tr>
<td>Step 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delivery Mode</td>
<td>-.779</td>
<td>.016</td>
<td>.459</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ref Year (2007-2008)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2000-2001</td>
<td>.008</td>
<td>.008</td>
<td>1.008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001-2002</td>
<td>.027</td>
<td>.008</td>
<td>1.027</td>
<td></td>
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<tr>
<td>2002-2003</td>
<td>.037</td>
<td>.008</td>
<td>1.038</td>
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<tr>
<td>2003-2004</td>
<td>.025</td>
<td>.008</td>
<td>1.025</td>
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<tr>
<td>2004-2005</td>
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<td>.008</td>
<td>1.031</td>
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<tr>
<td>2005-2006</td>
<td>.048</td>
<td>.008</td>
<td>1.050</td>
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<tr>
<td>2006-2007</td>
<td>.028</td>
<td>.008</td>
<td>1.028</td>
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</tbody>
</table>

Chapter Summary

This chapter provided an overview of the results of this study by examining the spatial distribution of the home-of-origin of on-campus and online students enrolled at Montana State University for the academic years 2000-2001 to 2007-2008 to identify possible spatial trends or patterns through time and between modes of delivery.
Additionally, basic demographics (age and gender) were assessed for the two populations over the specified time period to determine possible differences between groups and trends over the specified time period. A Chi Square test was used to provide a spatially unweighted assessment of “spatial” proportionality. The exploratory spatial data analysis tool GeoDa was used to assess the global and local spatial dimension of the research while ANOVAs, factorial ANOVAs, and logistic regression were used to assess the demographic research questions. The Chi Square tests indicated that there are significant differences in the proportion of registrations over time at the local, state and national level. Global spatial autocorrelation tests provide statistically significant, but moderately weak results. The LISA analyses and follow-up analyses point to considerable overlap in registration “footprints” between the on-campus and online registrations over the entire study period. Those tests also indicated that the changes in spatial patterns have been much more evolutionary for the online registrations than the on-campus registrations which showed considerably less variation over time. The demographic tests indicated that the on-campus and online populations differ both in age and gender composition. Conclusions drawn from the results of the study and recommendations for further research are provided in Chapter 5.
CHAPTER 5

CONCLUSIONS

Introduction

The problem addressed in this study was that university system and institutional administrators need to know who (geographically and demographically) the consumers of online courses and programs are. The purpose of this comparative study was to identify student populations and registration patterns over an eight year period in on-campus and online courses offered by Montana State University. Whether or not distinct student populations could be identified based on the mode of course delivery (on-campus vs. online) was established through the analysis of spatial and demographic data. The design of this project used a comparative approach to identify differences in population demographics and a spatially sensitive correlational approach (Getis, 2007) to identify associations between the spatial nature of on-campus and online registrations over time. The population included all on-campus and online course registrations (any individual could potentially register for multiple online or on-campus courses thus be counted multiple times based on the multiple registrations) offered through MSU from academic year 2000-2001 through 2007-2008, inclusive of summer semesters.

Results show that there are significant spatial and demographic differences between the populations. Within the online population, there have also been broad and significant shifts in the home-of-origin geographic patterns associated with those registrations over the eight year time span. There have been some considerably smaller, but still significant, changes in the spatial distribution of the homes-of-origin of on-
campus registration over the time period of the study as well. The overriding conclusion is that online registrations at MSU have indeed supplemented the campus registrations and not supplanted them.

**Research Questions**

The responses to the specific research questions addressed in this study are detailed below.

**Question 1**

*Are there different home-of-origin geographic patterns between students taking courses at MSU through the on-campus registrar process and those taking online courses from MSU?*

When viewing the univariate LISA cluster maps for on-campus registrations (Figure 56) and online registrations (Figure 58), which aggregate the registrations over the entire eight year study period, it is clear that the “core” geographic footprints show considerable overlap. Regardless of course delivery method, the bulk of the registrations come from Montana and its immediate periphery. Beyond the core, spatial overlap between the two course delivery methods still occurs at “outlying” population centers such as Minneapolis/St. Paul, Denver, Seattle/Tacoma, and Portland. Almost surprisingly, there is even overlap between some less populous areas like Bend, OR, the interior Colorado Rockies (Gunnison to Aspen), and the Carson City/Reno area of Nevada.
Despite the considerable spatial overlap between the on-campus and online registrations, as one would expect, the total distribution of online registrations is both more dispersed and shows greater variability over the “global” expanse of the lower 48 states than the spatial extent of the campus registrations which show greater spatial definition. However, the increased dispersion and variability at the global scale is, for the most part, ephemeral at the ZIP code cluster scale. In other words, at various times, a small number of individuals from a small cluster of ZIP codes may register for several courses online, perhaps complete them over the course of an academic year or two, and move on with their lives. When aggregated in the univariate LISA cluster analysis these transitory cluster show up as scattered High-Low and Low-High clusters.

Question 2

How do the home-of-origin geographic patterns compare and contrast over the eight year period, from 2000-2001 to 2007-2008, between the two groups?

When viewing the bivariate LISA cluster maps for the on-campus registrations over time (Figure 54), there is little spatial variation apparent. For the most part the High-High ZIP codes of the core (Montana and its periphery), and satellite High-Highs (Minneapolis/St. Paul, Denver, Seattle/Tacoma, etc.) are stable through time. Considering that Montana State University has been an established institution since 1893 and, relatively speaking, offers a consistent curriculum from year-to-year, the stability of the geographic footprint for on-campus courses is to be expected. The on-campus student population, to include its associated spatial characteristics, is well defined and largely consistent.
As evidenced by the Chi Square test (Table 1) and corresponding graph of in-state and out-of-state registration patterns over time (Figure 20), MSU has been steadily growing the proportion of registrations from non-resident students at the same time that the proportion of resident student registrations have been declining. So there have been shifts in the spatial footprint at the state level that may not be readily apparent through at the ZIP code scale of the LISA cluster maps. So, if a greater percentage of on-campus registrations are coming from out of state, what would that look like on the LISA cluster maps? Either the increase is spread across the existing out-of-state High-High clusters, the existing out-of-state High-High clusters are expanding, or new High-High clusters are developing.

One example of an interesting and significant development over the eight year time period is the growth of High-High clusters around the Burlington, VT area. This new recruitment area for on-campus courses began to develop in the 2004-2005 academic year and continued to expand at impressive rates through 2007-2008. The growth in that specific area can likely be attributed to a combination of things. One is the targeted recruitment in the New England area that MSU has undertaken over the past few years. Another is a potential student population in the Burlington area that may be looking for spatial “relief” out west, but a location that still reflects their interests and comfort zone (small community, “college town”, quality accessible skiing and other recreational opportunities, etc.).

Unlike the on-campus offerings, online courses from MSU began being offered, to a limited extent, in the mid 1990’s with the inception of National Teachers
Enhancement Network (NTEN). The NTEN program is essentially a stand-alone program run by Extended University with courses developed specifically for it that are not integrated into any on-campus program curriculum. It wasn’t until the end of the 1990s that “regular” MSU courses began being offered at a distance, and then the numbers were few. As can be seen in the time-lapsed bivariate LISA cluster maps for the online registrations (Figure 55), the spatial structure of the registrations for online courses has been in continuous development.

Keeping in mind the ephemeral nature of some of the online clusters mentioned above, what is most interesting about the development of the spatial structure of the online registrations over time is that its resemblance to the spatial structure of the on-campus registrations has, and continues to increase each year. The perception, based on the LISA cluster maps over time, that the online geographic footprint is getting more similar to the on-campus geographic footprint is corroborated through the Chi Square test (Table 1) and the graph identifying the changes in the percentage of registrations coming from various areal units (Figure 21). That graph (Figure 21) shows an ever growing percentage of registrations for online courses coming from resident students and an ever decreasing percentage of registrations coming from non-resident, or out-of-state, students.

When viewed together, Figures 20 and 21 indicate that at the state and larger (other states) scale, the two populations have been getting more similar over time. During the 2007-2008 academic year resident students accounted for 69.4% of the on-campus registrations; down from 75.7% in 2000-2001. Out of state residents in 2007-2008
accounted for 30.6% of the on-campus registrations; up from 24.3% in 2000-2001. Conversely, in 2007-2008, 60.9% of the registrations in online courses were from resident students; up from 26.2% in 2000-2001. The percentage of registrations from out-of-state students decreased from a high of 73.8% in 2000-2001 to 39.1% in 2007-2008.

**Question 3**

*Is there a significant difference in the basic demographic characteristics (age and gender) of students registering for on-campus and online courses over time?*

*a. Are there significant differences in the mean ages of the on-campus and online student groups?*

The factorial ANOVA indicated that there is a clear and significant difference in the mean ages of those registering for on-campus and those registering for online courses at MSU. As indicated in the relevant literature (Palloff & Pratt, 2003; Wallace, 1996, 2002) the online population is older than the on-campus population. As identified in this study, the difference in mean ages is about a decade.

*b. Have there been significant changes in the mean ages of the on-campus and online student groups over the specified time period?*

Also, based on the factorial ANOVA and one-way ANOVA with post-hoc test, there are statistically significant differences within each population, on-campus and online registrations, across the study period. However, in this case, the statistical significance should not overshadow the practical significance. The exceptionally large *n* for these tests almost assured that any differences would be identified as statistically significant. When looking at the means and standard deviations for the two groups over
the eight year period (Table 5), there are no clear and easily discernable trends evident with the possible exception of the standard deviation for the online registrations. With the exception of the 2000-2001 data, there does seem to be a trend towards decreasing standard deviations which indicates that the dispersion around the mean in decreasing, or the ages of those registering for online courses at MSU are getting (slightly) less scattered from the mean.

   c. Are there significant differences between the proportions of on-campus and online males and females for each year group?

   The results of the logistic regression indicate that the independent variable academic year of registration is a statistically significant predictor of the gender of course registrants. Again though, the practical significance is negligible (Table 8) and likely a function of the large $n$.

   d. How much of the changes, if there are any, in the proportions of males to females can be attributed to the year group and method of delivery over the eight year time period?

   More statistically and practically significant than the academic year of registration in predicting the gender associated with a course registration is the mode of course delivery. With the exception of some of the first few semesters of the study period, registrations from females online have consistently been higher, and often double the registrations for males during the same semester. On-campus, registrations for males have consistently outpaced registrations by females during the fall and spring semesters,
and just as consistently lagged behind the number of registrations by females during the summer semesters.

The most likely explanation for the gender differences by mode of course delivery have to do with the courses and programs that are available in a completely online format. The majority of the courses available and completely online from MSU are associated with K-12 teaching related or teacher preparation programs (the NTEN program, Master of Science in Science Education program, Northern Plains Transition to Teaching, and the Borderless Access to Training and Education programs) which draw from and attract and predominantly female population.

On-campus, the reversal in gender dominance during summer semesters is likely due to the similar reasons; that a greater proportion of summer on-campus course offerings are related to teacher preparation and continuing education than during the fall and spring semesters. The greater proportion of male registrations during the fall and spring semesters, despite women enrolling and graduating in greater proportions to men nationally (Almanac Issue, 2008), is likely a function of MSU being a Land Grant institution with programmatic emphases in engineering, agricultural studies and the sciences – all of which are typically studied by males at a higher rate than females.

Conclusions

The title of this study asks whether online course registrations are supplementing or supplanting on-campus registrations at Montana State University. To answer that question, the assumption is made that if the populations registering for online and on-
campus courses are the same, or becoming more similar as identified in some of the literature (Roach, 2002; Wallace, 1996), then the online courses may be displacing registrations that would otherwise be expected to occur in on-campus courses. The dimensions used to determine whether the on-campus and online populations at MSU were similar or becoming more so were the registrant’s home-of-origin ZIP code, age, and gender. While the inclusion of age and gender are self-explanatory, the inclusion of the home-of-origin ZIP code was based on the idea that on-campus courses had a relatively stable and predictable geographic “catchment area” over time. If the geographic catchment area for registrations for online courses varied significantly from the on-campus catchment area, that would provide another indicator that the population was different.

Based on the research presented above, the response to the principal question is that online courses are very likely supplementing and not supplanting campus registrations at MSU. While the geographic analysis points to the fact that there is significant, fairly extensive, and growing geographic overlap between the home-of-origin locations of online and on-campus populations, the age and gender differences clearly indicate that the online population is older and more female than the on-campus population.

The geographic analysis presented here indicates that regardless of the assumed ubiquitous availability of courses and programs, student’s familiarity with institutions (a function of distance and social networking, e.g. alumni, legacies, and other contacts, among other things) is still one of the most significant determinants of actual enrollment
in a college or university’s online courses. The geographic overlap between the two populations identified in this work suggests that while (within the physical, financial and political constraints identified in the Chapter 2) online education can be delivered anytime and anywhere, that does not mean that students anywhere, everywhere, and anytime will opt to take advantage of a given institution’s offerings.

Of particular importance, the finding that significant geographic overlap exists seems to be in accordance with the intent and goals of the Montana Board of Regents 2006-2010 Strategic Plan. One of the goals of expanding online learning in the Montana University System is to increase the enrollment of non-traditional students (presumably) within the state. Montana State University appears to be doing that.

As for the geographic variation between the online and on-campus populations, there were clearly some geographic hotspots identified by the LISA analyses in the online landscape that deviate from the on-campus landscape. There was also clearly greater geographic dispersion in the registrations for online courses in both space and time. The likely cause of the variation is the unique nature of many of the online programs at MSU. Academic programs (like other goods and services identified in the classic location theory literature), whether on-campus or online, that are either unique or considered exemplars will enroll students from a broader geographic audience.

Recommendations

The following recommendation is made based upon this study; online programs should take investment priority over individual online courses. As identified in the Hanna
& Oaks report (2007), “Demographic projections for Montana indicate that distance delivery programs offer the best opportunity for institutional growth”. The allocation of resources to developing complete online programs for delivery to Montana residents is more likely to meet the intent of the Montana Board of Regents Strategic Plan (grow enrollment and educational opportunities to more Montanans) than supporting the development of individual courses integrated into on-campus programs.

Further Research

Given some of the assertions in the literature that such an issue exists (Allen & Seaman, 2006; Blumenstyk, 2006, October 16; Carnevale, 2001; Guernsey, 1998; Pope, 2006; Wallace, 2002), and the potential impacts, empirical research to verify whether on-campus students are a significant and increasing proportion of the patronage of the online courses from their own institution is justified. An attempt was made to identify whether on-campus students were increasingly taking advantage of online courses by evaluating potentially changing proportions of registrations for on-campus and online courses by comparing their home-of-origin ZIP code and local ZIP codes. No discernable changes from year-to-year in the proportion of online course registrants with different origin and local ZIP codes were identified. Upon consideration by the researcher, the result was not a conclusion based on the appropriate data and that the data used was not appropriate to answer that question.

A second area where further research should is recommended would be to look at the registration rate relative to the capacity of areal units. This study looked at absolute registration rates, which from the past and current use perspective identified the students
who have registered. From the future recruitment perspective it would be valuable to know the relative proportion of the potential student population with an areal unit that the institution is serving. In other words, it would be useful to know what percentage of the registration carrying capacity we have met for each ZIP code. From the recruitment resources perspective, if an institution knew that they had reached 100% of the potential students in a given ZIP code, pouring significant additional resources into recruiting from that unit would be wasted. On the other hand if an institution has some consistent registrations from a ZIP code that has significant available carrying capacity, it indicates that the institution already has some level of “name recognition” that could potentially be leveraged to gain additional market share from that area.

Finally, further opportunities exist in parsing out and “drilling down” into the existing and other available data. As mentioned earlier, the number of “zero” cells is considered potentially problematic for the GeoDa analysis. Now that the initial analysis of the national pattern of course registrations has been completed, refining future analyses into smaller geographic regions to eliminate those “zero” areas and focus more closely on the areas where activity does exist might yield more refined results. “Drilling down” into the available data and expanding the fields available for analysis provide additional opportunity to spatial differentiation by level (graduate and undergraduate), department, program, etc. Adding additional data variables like SAT or ACT scores would not only provide administrators with a clearer picture of the student body, but also provide valuable information for strategic enrollment management and recruitment activities.
Chapter Summary

This chapter concluded that the online and on-campus student populations at Montana State University over the eighth year period from 2000-2001 through 2007-2008 are different populations. Geographically, there is considerable overlap between the home-of-origin ZIP codes of the two populations. However, the significant differences between the online and on-campus populations in mean ages and gender precludes the possibility that the populations are identical despite the overlap. While there is greater spatial and temporal dispersion within the geographic extent of the online registrations, this is to be expected based on the increased availability of those courses without the associated commitment required of, or added inconvenience to distal or otherwise engaged students.
REFERENCES


Morrill Act of 1862, United States Statutes at Large 12: 503, 7 U.S.C. 301 *et.seq.*


