7-3-2012

THE ACADEMIC LIBRARY IMPACT ON STUDENT PERSISTENCE: TWO MODELS

Mark Emmons

Mark Emmons
Candidate

Educational Leadership
Department

This dissertation is approved, and it is acceptable in quality and form for publication:

Approved by the Dissertation Committee:

Dr. Allison M. Borden, University of New Mexico
Chairperson

Dr. Alicia F. Chávez, University of New Mexico

Dr. Eliseo Torres, University of New Mexico

Dr. Ethelene Whitmire, University of Wisconsin

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TWO MODELS

BY

MARK EMMONS

B.A. Communication Studies, University of California, Los Angeles, 1983
M.L.S. Library & Information Science, University of California, Los Angeles, 1990

DISSERTATION

Submitted in Partial Fulfillment of the
Requirements for the Degree of
Doctor of Education

Educational Leadership

The University of New Mexico
Albuquerque, New Mexico

May 2012

DEDICATION

I dedicate my study to every librarian who has made a difference in the life of a student.

ACKNOWLEDGEMENTS

When I first embarked upon my dissertation, I had no idea what a truly solitary activity it could be. I am so grateful that there were so many people who sustained me in my studies. It would have been impossible to complete my research and my writing without guidance from my committee, help from my colleagues, and support from my family and friends.

First and foremost, I would like to thank my chairperson, Dr. Allison M. Borden, for her sensible and informed direction and understated counseling. I have learned so much about investigating and expressing my ideas with statistics and translating numbers into words. I enjoyed my meetings with her to discuss my latest additions and my next steps. She truly went beyond the call of duty to make sure that I could graduate with my colleagues. I would also like to thank my original chairperson, Dr. Alicia F. Chávez, in her role as committee member for her encouragement and for keeping me focused on student success. I would like to thank Dr. Ethelene Whitmire for keeping me grounded in librarianship. I would like to thank Dr. Eliseo "Cheo" Torres for his insightful commentary. And I would like to thank Dr. James Selig who stepped in with recommendations on loosening the constraints on my structural equation model when I first realized that it would not fit.

Members of my Educational Leadership cohort succored me. Fran Wilkinson and I made a pact to enter the program together, work on joint projects when at all possible, and to finish at the same time. Though we could not work on a dissertation together, we agreed to back each other each step of the way. Kathy Alexander joined us and we became a trio, meeting regularly over meals to report our progress, share ideas, and cheer

each other's success and spirits. Thanks to each other, we all made it and will be marching forward together.

No thanks would be complete without my family. My wife Loraine and my daughters Michelle and Natalie put up with me as I abandoned them for many weekends holed up at the formal dining room table that became my office or on the bed in the master bedroom stretched out with my laptop surrounded by books and papers. My neglected chores somehow always got done. But, more important was the encouragement they gave me and the patience they showed as my work on my dissertation stretched on.

My parents passed away years before I began the Educational Leadership program at the University of New Mexico, but I wouldn't be pursuing a doctoral degree unless they had laid the foundations that made me value education. Finally, I would like to thank my grandpa, Frank Bottarini. He dropped out of school after eighth grade to apprentice and work his way up to a career as a master machinist. He always valued "practical" learning and would tease me with a twinkle in his eye about my "book" learning, calling me "perfessor" long before I even considered becoming one. He helped found a union local back in the days of union busting. He was a leader of men and much of what I believe about leadership I learned sitting on the arm of his armchair.

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Ed.D. Educational Leadership, University of New Mexico, 2012

ABSTRACT

The study assessed the impact the academic library has upon student persistence by analyzing two models: (1) a structural equation model that added a library construct to an existing model of student persistence with constructs for academic performance, academic integration, institutional support, intent to persist, and persistence and (2) a multiple regression model. The measures for the library construct included librarians, expenditures, materials circulated, and instruction. Data from the 2006 Integrated Postsecondary Education Data System, Academic Libraries Survey, and the National Survey of Student Engagement served as variables for the constructs and yielded a sample of 497 institutions. The structural equation model did not fit and did not explain the nature of the relationship between the academic library and student persistence. The taxonomy of multiple regression models analyzing the relationship between graduation and the independent variables from the structural equation model revealed that an increase in the ratio of librarians to students or an increase in library expenditures per student predict a higher graduation rate. The lack of fit in the structural equation model is

likely due to the inadequacy of library input and output measures that indicate size more than quality. The results suggest that librarians need to devise outcome and value measures at their local institutions and that national library organizations need to develop measures and techniques that can be used by administrators to make decisions when allocating resources and by researchers to demonstrate the academic library's impact upon student success.

Keywords: academic libraries, college students, academic persistence, assessment, evaluation, measurement, outcomes, impact, value, structural equation modeling, multiple regression analysis

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CHAPTER 1:

INTRODUCTION

"The library is in a most important sense, the center of the University life"

Timothy Dwight

The sentiment attributed to the President of Yale University is a time worn cliché. The academic library has regularly been defined as the center or the heart of the university, so much so that similar views can be traced back to 1893 (Katz, Bunge, & Rothstein, 1989, p. 42). But is it true? As a symbol, perhaps; but what impact does the academic library really have on student success? As an academic librarian, this is a question I have been asking myself in one form or another for the past twenty years. At first, I was content to improve my own skills as a librarian to better serve student needs. As I became more experienced, I grew more interested in providing evidence that the services I offered made a difference. Initially, my inquiries took the form of simple tests and experience surveys that I used to improve services. Later, I conducted research with colleagues to investigate whether the library made a difference in student success as they wrote papers (Emmons & Martin, 2002) and in information literacy skills (Emmons, Keefe, Moore, Sánchez, Mals, & Neely, 2009). Though the results showed that the library made a modest difference in student success, I still was not the satisfied. While I was pleased with the small influence my instructional program had upon student learning outcomes in two sets of courses, I wanted to know what impact library in general has upon student success. I was interested in showing that the library gives value to the areas that matter to the University.

As a result, my colleague Fran Wilkinson and I conducted a study that explored the relationship between traditional library input and output measures of staff, collections, use, and services with fall-to-fall retention and six-year graduation rates at Association of Research Libraries member libraries. Our linear regression analysis found that a change in the ratio of library professional staff to students predicted a statistically significant positive relationship with both retention and graduation rates (Emmons & Wilkinson, 2011). This time, I was quite pleased with the results. Our study showed that librarians had an impact upon at least one measure that matters to the university. Our study did not, however, explain *why* the ratio of professional staff to students has an impact on student persistence. My study takes one approach to explaining why librarians might have an impact on student persistence by utilizing a structural equation model and a multiple regression analysis to answer the question: What impact does the academic library have on student persistence?

Impact and Value Measures in Academic Libraries

My interest in impact measures parallels a similar interest in the academic library community. Traditionally, academic libraries have used input and output measures to evaluate their services, with the importance of the library to the campus and its students assumed. Input measures count resources added into the library such as staff, collections, space, or expenditures. Output measures calculate use of resources and services such as visits, collections use, reference transactions, and classes taught. Very little has been published on the academic library's contributions to institutional goals. This was confirmed by a series of literature reviews conducted in the 1990s by Powell (1992), Pritchard (1996), and Gratch-Lindauer (1998).

Powell (1992) reviewed the research literature on the impact student academic library use has on academic performance. He found that most of the literature focused on input and output measures with very little attention to impact. He did cite impact studies that correlated academic library use and library skills with lower attrition rates, higher student persistence, and better grades and GRE scores.

Pritchard (1996) presented a range of methods involved in assessing the quality of academic libraries. She called for libraries to combine traditional methods with assessment of user needs and application of Total Quality Management principles. She noted that "more research is needed that will lead to agreed-upon measures of library- and information-related outcomes in higher education..." that "…include information literacy, success in graduate school, success in job seeking…" among other measures that promote attainment of the university mission (p. 591).

In 1998, Gratch-Lindauer built upon Powell's literature review, still finding that the majority of research "measuring inputs, processes, and outputs. However, almost none of these publications provide measures or methods for assessing the impact of academic libraries on campuswide educational outcomes" (p. 548). The purpose of Gratch-Lindauer's article was to make a case for measuring a library's impact on institutional outcomes such as access, institutional viability, and impact on learning outcomes.

Library Associations

National library associations began to call for assessments based on impact. The Institute of Museum and Library Services (IMLS), a federal funding agency for libraries and museums (Institute of Museum and Library Services, 2010) presented two opinion papers on outcomes-based evaluation. In the opening sentence of the abstract introducing

both papers, IMLS claimed, “If museums and libraries are to compete for both public and private funds in an accountability-driven environment, they must develop evaluation practices that provide the most compelling picture of the impact of their services” (Institute of Museum and Library Services, 2000, p. 1). In the essays, they called for outcomes-based measures. In a follow up study funded by the IMLS, Durrance and Fisher-Pettigrew (2002) called for “context-centered approaches” to determine “what has changed as a result of our work” by focusing on user needs (p. 48). Though their research focused on the public library rather than the academic, it was indicative of the drive to discover what impact the library has on its users, with findings including benefits to individuals, families, and the community.

The Association of Research Libraries (ARL) is “a nonprofit organization of 125 research libraries at comprehensive, research-extensive institutions in the US and Canada” (Association of Research Libraries, 2010a). Traditionally, ARL has produced an annual ranking of member research libraries based on an algorithm combining input and output measures under the assumption that these numbers reflect on the quality of the library. Dissatisfaction with that assumption led ARL to hold a 1999 retreat which resulted in the ARL *New Measures* initiative (Association of Research Libraries, 2010c). As a result, ARL commissioned two studies exploring alternative means of measuring quality. Introducing the first study, ARL Director of Information Services Blixrud noted that the measures were designed to respond to “two challenges currently facing research libraries. The first is to demonstrate how research libraries have an impact in areas of importance to their institutions; the second is the increasing pressure to maximize the use of resources” (Blixrud, 2001, p. 27). In the first study, Smith recommended that libraries

replace input and output measures with student learning outcomes such as measures of information literacy and student research (Smith, 2001). In the second study, Fraser, McClure, and Leahy (2002) developed a model for assessing library and institutional outcomes that tied library activities to campus vision, mission, and goals. The authors did not explicitly describe means of assessment, but stressed aligning measures with local institutional mission and goals.

In 1998, the Association of College and Research Libraries (ACRL), an organization serving the needs of academic librarians, realized that "the association has no statement on outcomes assessment, and that its standards, largely written as input measures, are out of step with the practices and philosophy of regional and professional accrediting agencies and state higher education agencies" (Association of College & Research Libraries, 1998, p. 1). As a result, ACRL decided to form a task force on outcomes. Emerging from the task force in 2004 was a new version of its *Standards for Libraries in Higher Education*. While earlier standards focused on input measures such as collection and building size and number of staff, the new standards focused on "documenting the library's contribution to institutional effectiveness and student learning outcomes" (Association of College & Research Libraries, 2004, p. 1).

In recent years, the movement has evolved under the label of *value*. In 2009, ACRL launched a new strategic plan that made multiple references to recognizing the "value of the library" and then made it a strategic priority for 2009-2013 to "increase recognition of the value of libraries and librarians by leaders in higher education, information technology, funding agencies, and campus decision making" (Association of College & Research Libraries, 2009, p. 1). ACRL Presidents Snelson and Goetsch both made

identifying the value of the academic library a priority of their terms. Snelson (2006) noted that "there *is* a paucity of research on the value of academic libraries" and that she "would make communicating the value of academic libraries the focus of [her] ACRL presidency" (p. 490). Goetch built upon Snelson's platform. In an editorial entitled, "What is our value and who values us?," she explained the need to "identify research and data gaps and help the board determine tools to be developed, as well as other research that needs to be conducted" in the context of the library's primary goal to support the larger institution's mission (Goetsch, 2009, p. 503). In the same editorial, she noted that ACRL commissioned a literature review and report by Oakleaf and charged the ACRL Assessment Committee with developing a toolkit that librarians can use to conduct local value studies.

In her resulting literature review, Oakleaf (2010) examined how academic, school, public, and special libraries have measured their value and then made recommendations to ACRL on next steps ACRL might take to demonstrate academic library value along with a proposed research agenda. Oakleaf agreed with the previous decade's literature reviews and Snelson's conclusion about the dearth of research on the value of academic libraries. Shortly afterwards, the ACRL Assessment Committee launched a website that "highlights the increasing number of studies and resources outside of the traditional scholarly literature that focus on demonstrating and documenting the evolving practices of library assessment and evaluation" (Association of College & Research Libraries, 2010c, p. 1). The toolkit lists a couple of dozen resources that librarians can use to assist in their own efforts to demonstrate the value of their libraries. Overall, the initiatives

launched by library associations indicate that the movement to demonstrate the value of the academic library to higher education is blossoming.

Accountability in Higher Education

The movement in academic libraries from input and output measures to outcomes and values measures has taken place in the context of a movement toward greater accountability in higher education. Librarians have been well aware of the trend toward accountability, as reflected by the environmental scans identifying the top trends that will impact academic libraries regularly conducted by the ACRL Research Planning and Review Committee (Association of College & Research Libraries, 2010b). For two reports in a row, the Committee noted the trend that "increasingly, academic libraries are required to demonstrate the value they provide to their clientele and institutions" (Association of College & Research Libraries, 2010a, p. 287).

Alexander (2000) traced the roots of this movement toward greater accountability in higher education to the fact that the government began to see higher education as a key economic driver in the 1990s. Often seeing higher education as non-responsive to society's needs, the government began to seek more control of higher education with calls for performance-based accountability and efficiency measures.

The most significant example of calls for accountability was the Spellings Commission report. In 2005, then Secretary of Education Margaret Spellings appointed a commission to examine the state of higher education. Though the commission report praised much in United States colleges and universities, it was critical on issues of access, affordability, learning, accountability, and innovation in higher education (Spellings, 2006). On accountability, the commission recommended, "accreditation agencies should

make performance outcomes, including completion rates and student learning, the core of their assessment as a priority over inputs or processes" (Spellings, 2006, p. 25). The parallels in language between the recommendations of Spellings Commission and the various national library organizations are too obvious to ignore and make it likely that they were observing the same trends described by Alexander (2000).

In a book written to make a case to directly measure student learning and provide a framework to do so, Shavelson (2010) defined terms, traced the history of accountability in the United States, and set the policy context for assessment and accountability. His definition examined the features of accountability, which included responsibility for actions and outcomes and responsibility to authority along with the notion that presumed capability and causality (Shavelson, 2010, p. 122). He traced the history of accountability in higher education from self-regulation to accreditation to state level accountability to associations providing voluntary means of demonstrating accountability. Furthermore, he noted that the Spellings National Commission Report spurred considerable debate within the higher education community that has had a direct impact on policy. Together, the context he provided paints a picture of increasing accountability in higher education.

In 2009, ACRL wrote a *Strategic Thinking Guide for Academic Librarians in the New Global Economy* summarizing the "turmoil" in higher education (Deiss & Petrowski, 2009). The guide points to the flailing economy, the government's view of "higher education as one antidote for economic decline," and sweeping changes in technology as reasons for "librarians to embrace systemic change" (p. 3). Academic libraries are faced with the accountability defined by Shavelson and the turmoil described by ACRL.

Additional Factors

Scarce Resources.

ACRL regularly produces a list of the top ten trends in academic libraries. The most recent iteration stated, "budget challenges will continue and libraries will evolve as a result" (Association of College & Research Libraries, 2010a, p. 287). The report goes on to point out that budgets are stagnant or reduced, endowments are down, and the proportion states spend on higher education continues to diminish. The ACRL *Strategic Thinking Guide* offered up more developments, noting that giving to higher education had reached a plateau, students were more reluctant to take out loans, and federal spending would likely diminish substantially after the stimulus funding was exhausted (Deiss & Petrowski, 2009, p. 4).

Three different articles made an argument to transform the academic library by aligning its services with the core mission of the university. Simmons-Welburn, Donovan, and Bender (2008) pointed out that higher education institutions have "been battling budget scarcity since the troubled decade of the 1970s" (p. 130) and that instead of responding incrementally, library directors should respond by transforming the library. Lougee made the same argument, pushing transformational change over incremental change by focusing on library alignment with university goals (Lougee, 2002, 2009). In Australia, Bosanquet (2007) produced an inventory of factors that contribute to the need for change. Among these are reduced budgets, competition for institutional resources, and the corporatization of higher education – all factors similarly cited in the American literature.

In the U.S., state and federal governments have always been responsible for public higher education, but only in the last decade of the twentieth century did they begin asking colleges and universities to justify their existence by assessing quality outcomes for students. In turn, administrators have begun to ask their academic libraries to provide evidence that they, too, are serving the needs of students (Alexander, 2000; Shavelson, 2010).

Competition

Competition from other information services has been a fact of life for libraries for so long now that ACRL did not mention it as a trend in the latest top ten trends list (Association of College & Research Libraries, 2010a). It is now accepted as a matter of fact that libraries face competition from web providers and traditional library vendors that now market directly to students and faculty. In making a case for the importance of developing their *Taxonomy*, Saracevic and Kantor (1997a) noted that as information has become more important to an information society, new "players" have emerged that are "beginning to provide information services – and they are competing directly with libraries" (p. 528). With easily and freely available information available on the Internet, students will now often bypass the library. Even when the library is providing electronic resources, students and faculty are not always aware that they are using resources that the library has purchased.

Justification

Heightened accountability, reduced budgets, and competition from other information providers provide the context for my study. It is essential that librarians are able to make a case to university administrators and state legislators that the academic

library has value. I hoped to make a case for the academic library's value by linking traditional library input, output, and outcome measures to existing models that show student engagement and academic performance have a significant impact upon student persistence.

Value: Models and Definitions

In the mid-1990s, the Council on Library Resources (CLR), whose "mission is to expand access to information, however recorded and preserved, as a public good" (Council on Library and Information Resources, 2010, p. 1) took a somewhat different approach to exploring the library's impact. CLR sponsored a study on the value of library and information services. Researchers were charged with developing a taxonomy of library value and proposing methods of measurement. The result was the *Derived Taxonomy of Value in Using Library and Information Services* (Saracevic & Kantor, 1997a, 1997b) and several additional articles on how to practically apply the *Taxonomy* in value studies (Abels & Kantor, 1996; Huttenlock, Dawson, Saracevic, & Kantor, 1995; Kantor & Saracevic, 1995).

In the first part of their report, Saravecic and Kantor (1997a) drew on philosophical and economic theories of value to generate two models and define value. From philosophical theories they distinguished between the intrinsic value of information and the extrinsic and contributory value of information services. From economic utility theories they propounded a value-in-use of information. The result was two related user-centered models: (1) the model on the use of information is A-C-A or Acquisitions-Cognition-Application and (2) the model on the use of information services is R-I-R or Reasons-Interaction-Results. Saracevic and Kantor defined value as:

> the value of a library and information service is an assessment by users…of the qualities of an interaction with the service and the worth or benefits of the results of the interaction, as related to the reasons for using the service. (p. 540)

In the section on the value of library services, they called for different approaches for studying social, institutional, and individual value. Of most relevance for impact studies was the institutional level, in which "value should be linked to the mission and progress of the institution (such as education…). For example, academic libraries are considered to be indispensable for research and education in universities, thus they have a value for the university" (Saracevic & Kantor, 1997a, p. 538). Note that the authors felt it is almost impossible to show the benefit of the academic library at the institutional level and argued for study at the individual level in the context of the larger institution (p. 539).

In the second part of their report, Saracevic and Kantor (1997b) presented their *Taxonomy* for use in studying the value of library services and to further build theory. The *Taxonomy* is structured according to their R-I-R model and includes reasons for using the library, interactions with library resources and staff, and results of using the library with extensive examples making up each classification.

Though the CLR study is among the most thorough attempts to provide a definition of the value of the library, it was not the first. Orr (1973), in a paper exploring the "relative advantages and disadvantages of different quantitative measures," (p. 316) asserts that the "principle yardsticks needed by the Librarian, aside from measures of costs, would ideally be direct measures of capability, utilization, and value for each of his library's services" (Orr, 1973, p. 323). These three measures correspond respectively to

input, output, with value covering both outcomes and impact. See Figure 1.

Figure 1: Orr's Library Measurement Model

In a textbook on the evaluation of library services, Matthews (2007) expanded upon Orr's model of Input → Process → Output → Impact/Effect. Input measures include "five broad categories: budget, staff, collections, facilities, and technology" (p. 20) Process measures are internal productivity measures. Output measures indicate use. Outcome measures refer to the impact on the customer. Matthews extended Orr's model to include his own definition of value, which he defined as the long term impact of outcomes. See Figure 2.

Figure 2: Matthew's Library Measurement Model

ARL Senior Program Officer for Statistics and Measurement Kyrillidou (2002) came up with a similar definition. She defined inputs as "the resources available to the system" and outputs as "the activities the system exports" (p. 43). She associated outcomes measures with quality and broke them into categories.

Within the ARL New Measures agenda there were at least four implied definitions of outcomes in terms of how various working groups and projects are approaching the issue:

> (1) learning outcomes, (2) research outcomes, (3) institutional outcomes, and (4) personal control or electronic service quality issues. (p. 45)

She went on to describe examples of projects in each area with the exception of institutional outcomes, confirming once again that little has been published in this area. Ultimately, her goal was to develop a model that combines input, output, outcome, and quality measures.

In guidelines she was asked to develop as part of a book on evidence-based practice for information professionals, Urquhart (2004) defined performance measures. She described inputs and outputs by example as "service inputs (human resources, materials), or service outputs (e.g. documents supplied, training sessions delivered)" as part of a larger model in which outcomes are defined as "how the users use library service outputs to help them provide better quality services or products" (p. 211). Though virtually identical to Matthew's model, she added the category of user. See Figure 3.

Figure 3: Urquhart's Library Measurement Model

In the context of preparing librarians to conduct an evaluation study, Powell (2006) summarized the evaluation research methods used in library and information sciences. He grouped the methods into three categories. "Input measures are measures of the resources that are allocated to or held by an organization" and are "more measurement than true evaluation and are limited in their ability to assess quality." Output or performance measures "serve to indicate what was accomplished as a result of some programmatic activity" that focuses "on indicators of library output and effectiveness." Impact and

outcomes assessment measure “how the use of library and information resources and services actually affects users” (pp. 105-106).

In an article written to reveal the importance of impact measures to libraries, Poll and Payne (2006) developed a model that traced measurements from input to activities to output to outcome. As did many other studies, they defined input and output by offering examples of each: “inputs into services (funding, staff, collections, space, equipment)” and “outputs of those services (e.g. loans, visits, downloads, reference transactions)” (p. 548). They used the ACRL (2004) definition of outcomes: “the ways in which library users are changed as a result of their contact with the library's resources and programs” (p. 548) and grouped both impact and value under the outcome category. Poll and Payne (2006) added to the ACRL definition by including the impact that use of library resources and services has on the parent institution:

What universities want to achieve can be summarized thus:

1. Recruitment and retention of students and excellent academic staff.
2. Effective teaching, resulting in:
    - high graduation rates;
    - high grades in examinations;
    - high employment after examinations.
3. Effective research, resulting in:
    - high valuation and use of research results and publications;
    - high amount of special grants;
    - status, awards, honours. (p. 550)

They claimed that “most of these goals can be supported by library services, and libraries should try to prove the connection between use of their services and the institution’s success” (p. 550). The rest of the article delineated methods for assessing impact and gave examples of impact studies conducted in the United Kingdom.

In a similar fashion, Ackermann (2007) contrasted tradition library input and output measures with outcome measures. He noted that “most library assessment is developed in relative isolation from the larger higher education community” (p. 7) and called for measures that are meaningful to campus stakeholders.

These characterizations of library value all share a common definition for input and output measures, but they differ in output and impact measures. Some use outcome and impact as synonyms (Ackermann, 2007; Urquhart, 2004). Others treat outcome as an overarching category that incorporates impact or value (Kyrillidou, 2002; Orr, 1973; Poll & Payne, 2006). And still others define outcome as short-term and impact as long-term (Matthews, 2007). For the purposes of this study, I use the ACRL definition of outcome: “the ways in which library users are changed as a result of their contact with the library's resources and programs” (Association of College & Research Libraries, 2004, p. 1) but reserve the term impact to mean the measurable effect the academic library has upon goals that are important to the parent college or university.

Additional Definitions of Value

In her exhaustive and up-to-date literature review, Oakleaf (2010) explored the variety of methods that academic libraries have demonstrated value. She noted that of the different “ways of defining value, library stakeholders tend to focus on two: financial value (also commonly referred to as return-on-investment) and impact value” (p. 15).

Return-on-investment (ROI) is more an efficiency and effectiveness measure than it is an impact measure. Urquhart's (2004) model defines efficiency as a measure of library output per input while effectiveness is a measure of outcome per input. Impact is measured by outcomes valued by the user – her model provides a means of seeing what impact changes in input and output measures have on outcomes desired by the user. Urquhart's suggested approach is economic and has similarities to ROI.

Whitehall (1995) wrote a literature review on value in order to make a case for using economic measures to make allocation decisions. He concluded: "the cost of providing services without being able to demonstrate their value and quality is that we leave the initiative to people whose chief concern is cost control or profit: the funders and the vendors" (p. 10). ROI is an example of the type of economic measure he gives as an example. Claiming to be the first study of its kind in academic libraries, the University of Illinois conducted a ROI study modeled on the work Strouse (2003) had conducted in corporate libraries. They that found a 4 to 1 return on grant income generated by faculty use of library materials (Kaufman, 2008; Kaufman & Watstein, 2008). Impressed with the results, ACRL has commissioned a return on investment study that will be completed in 2013. My interest in value has to do with impact and will not deal with ROI.

Persistence

I would like to make a case for the academic library to both library and campus administrators in order to at minimum maintain current levels of support in these difficult economic times and ideally to expand support when budgets improve. I chose a measure that matters to colleges and universities nationwide. Kuh (2007), in the appendix to the ASHE Higher Education Report, provided a list of 14 indicators that have been used in

studies of student success in higher education. He, in turn, adapted the list from an earlier compilation for the American Association of Community Colleges. Indicators include student goal attainment, course retention and success, success in subsequent coursework, fall-to-fall persistence, time to degree, degree completion, graduate school enrollment and employment, transfer rate and success, employer assessment of students, academic value added (knowledge, skills), student experience, student professional growth and development, student involvement, and citizenship and engagement. Of these measures, retention measured as fall-to-fall persistence and graduation measured as degree completion are perhaps the most commonly used measure of student success (Pascarella & Terenzini, 1991, 2005). Colleges and universities are required to report retention and graduation figures and the data are readily available at the NCES web site. Together, retention and graduation are known as persistence. I therefore used persistence as my measure of student success. I was hoping that the results would be valuable to administrators in higher education and in academic libraries as they make decisions on how to allocate resources.

Research Question and Hypothesized Model

My research question asked: What impact does the academic library have on student persistence?

Given the complexity of the library's impact on student persistence, I used structural equation modeling to test a hypothetical model that theorizes an indirect effect of the library upon persistence. I added a library construct to a structural equation model developed by Cabrera, Nora, and Castañeda (1993) which in turn was based on the work of Tinto (1987) and Bean and Metzner (1985). Based on the models of Matthews (2007)

and Urquhart (2004) that built upon Orr (1973), I posited that library input and output measures would have a statistically significant direct impact upon the constructs of academic integration and academic performance and an indirect impact upon persistence.

No such connection has been made before. In fact, structural equation modeling is little used in the library sciences, and I have been unable to find a single example used in the context of student success in higher education.

CHAPTER 2:

LITERATURE REVIEW

Evidence tying academic libraries to student persistence is scarce. Pierard and Graves (2007) reviewed the higher education and library literature on retention and found only a handful of studies. Their goal was to develop a framework that academic librarians could use as a "lesson" to assist with retention efforts. They argued that librarians should be "(a) integrating libraries into institutional retention efforts; (b) employing information literacy as a means of promoting student engagement; and (c) re-engineering library spaces as centers for student learning and community" (p. 161).

Pierard and Graves were not alone in appealing to librarians to explore linkages between the academic library and retention and graduation. Poll and Payne (2006) argued that "the library's mission and goals must be adjusted to those of its parent institution," (p. 550) including retention and graduation. Bell (2008) argued that library directors should make the case that the academic library could be valuable to boosting retention, sharing a variety of potentially successful strategies. He felt the library director could make a case if they followed his:

five-point plan:

- Emphasize the delivery of individualized research assistance and personal attention.
- Focus on research skill building as a core contributor to student academic success.
- Provide data that links student persistence and Experience to the library's services, resources and people – not just collections

- Demonstrate how the library can contribute to a campus-wide effort that uses perks and incentives to keep students till graduation.
- Explore ways to involve the library in working with parents in supporting student success. (p. 2)

Most recently, ACRL called upon librarians to demonstrate the value of academic libraries by exploring all type of impact measures, including retention and graduation (Oakleaf, 2010). Though these authors pleaded for new studies, they were not unaware of librarians' long but inconsistent history of linking the academic library with retention and graduation. Instead, they saw a new urgency to demonstrating the value of academic libraries and librarians.

Early studies tended to look at individual institutions. In perhaps the first study linking an academic library to student persistence, Kramer and Kramer (1968) found a statistically significant correlation between persistence and students who checked out at least one book in their first year at California State Polytechnic College-Pomona versus those who did not check out any books. They noted, "of those students who used the library, 73.7 per cent returned. By contrast, the fate of those freshmen who never used the library was that only 57 per cent returned" (p. 312). Theirs was part of a larger study that also found that library use correlated with higher grades (Barkey, 1965).

In a study conducted at Louisiana State University, Wilder (1990) found that library jobs improved student retention, arguing that exposure to the library and its resources were a positive influence. At Loyola University in New Orleans, Rushing and Poole (2002) reported similar results, finding that students who had worked in the library graduated at a higher rate than the student body, discovering that 61.5% had graduated,

which was "significantly higher than the university's four-year average of 31 to 38 percent" (p. 93). In neither case is there evidence of statistical analysis or of controlling for other possible explanatory factors – such as on-campus employment, for instance. But, the findings are none-the-less interesting.

Only recently has research looked directly at the relationship between academic libraries and persistence across multiple institutions. Mezick (2007) studied the relationship between traditional library input and output measures of expenditures, materials, and salaries with fall-to-fall retention rates and found that there was a moderate correlation, with the strongest correlations occurring at doctoral institutions. Mezick did not control for any non-library factors other than institution type, but the correlations that she found are still intriguing and point to input and output measures potentially related to persistence. Emmons and Wilkinson (2011) explored the relationship between traditional library input and output measures of staff, collections, use, and services with fall-to-fall retention and six-year graduation rates. A linear regression model found that, controlling for ethnicity and socioeconomic status, a change in the ratio of library professional staff to students predicted a statistically significant positive relationship with both retention and graduation rates at Association of Research Libraries member libraries.

Other multi-institutional research has looked at the library under the broader umbrella of expenditures. Gansemer-Topf and Schuh (2006) investigated how institutional expenditures contribute to retention and graduation. They "found that there is a relationship between organizational behavior (i.e. resource allocation and institutional selectivity) and retention and graduation rates" (p. 629). Among others, their "study verified that academic support expenditures positively contributed to retention and

graduation rates" (p. 632). Noting that the library, along with advising and academic computing are part of academic support, they go on to state that it is difficult "to determine if the separate functions within academic support expenditures contributed to retention or graduation rates equally of if some have more influence on retention and graduation rates than others" (p. 632). Unfortunately, most studies examining expenditures took the same approach, finding that spending on academic support services improved retention, but not separating out the various types of academic support services (Astin, 1993; Ryan, 2004). Their reluctance is understandable, as the category of academic support services is one of many areas of higher education spending defined by National Center for Education Statistics (NCES) and Integrated Postsecondary Education Data System (IPEDS) – the library is only one of several services subsumed under academic support services and separate numbers are not generally reported.

Despite these difficulties, two expenditure studies did separate out the library. Hamrick, Schuh, and Shelley (2004) developed a statistical model that included institutional expenditures. They fit a multiple regression model to their data and found that increasing library expenditures was second only to "increasing per student expenditures for instruction" (p. 12). "Library expenditures (LIBEXP) provide a very robust and statistically significant explanation of graduation rates ($f = 230.422$, $p < .001$, $R^2 = .343$). Every 10% per student headcount increase in library expenditures ($36.05) results, on average, in an additional 1.77 percentage points of graduation rates" (p. 11). At the University of Tennessee, as part of a larger study on the impact that using campus facilities had upon the retention of students from their first to their second year, Mallinckrodt and Sedlacek (2009) found "that students who use the library are more

likely to stay in school" (p. 569). In particular, there was evidence that students who studied in the library, used the library for research, and who spent more hours in the library were significantly more likely to return for their second year. For Black students, statistical significance was limited to studying in the library.

What little research that exists tying the academic library to student persistence is encouraging, demonstrating a positive relationship with library resources, services, or use to student retention or graduation.

The Academic Library and Student Academic Performance

Most academic library impact studies focus not on persistence, but on student achievement and learning or on evaluation of programs with the intention of making programmatic improvements; only a small portion of the studies present empirical research.

Perhaps the earliest systematic attempt to examine impact was the Monteith College library experiment (Knapp, 1966). Interested in "methods of developing a more vital relationship between the library and college teaching" (p. 11), librarians planned courses with faculty that involved "extensive and meaningful use of the library" (p. 12) and found that students who participated made better use of the library and performed better in classes. They used their findings to call for the development of instructional partnerships between librarians and faculty, playing a key role in the development of library instruction programs in academic libraries.

Several studies explored the academic library's impact on learning. In two separate studies, Whitmire (1998, 2002) analyzed library factors that contribute to the development of critical thinking skills. In the first study, she found (among other non-

library factors) that "students engaged in more focused library activities reported a significant impact on their critical thinking development" (Whitmire, 1998, p. 7). In the second study, she found that libraries with greater resources had a significant impact on students' self-reported gains in critical thinking (Whitmire, 2002). Julien and Boon (2004) gave pre- and post-tests and interviewed students in a Canadian university and established that library instruction contributes to student's overall success in school.

Other studies looked at the link between library use and student success. Bolt (1986) compared students who failed competency examinations and subsequently took a library instruction course to students who successfully tested out of the course and found no discernible difference in test scores, implying that the course impacted student performance. At Miami University, Erekson (1992) studied the impact student effort in studying, using the library, and working with faculty had on achievement. He found that "library effort did not have a significant effect on GPA" (p. 441) and neither did studying – only time with faculty made an impact. Richland College found that students who had completed the Certificate of Information Literacy – a five course sequence – had higher grades and a better retention rate than students who did not (Ferguson, 2000). de Jager (2002) correlated book borrowing with better scores on exams. Dickenson (2006) surveyed undergraduates and faculty to determine how academic libraries in Colorado impact student learning. While the student survey focused primarily on how they used the library rather than on their learning, one part of the faculty survey did find that most faculty felt that the library contributed to their teaching. Zhong and Alexander (2007) surveyed students who responded that access to library facilities and to technology and online resources contributed to their academic success.

At Arizona State University, Churchill and Iwai (1981) examined the impact campus facilities had on retention of students with high and low grades. The library was one of nine campus facilities in a large conglomerate that included "campus housing, campus food services, recreational facilities, academic advisement, career services, financial aids, student health services, and the university counseling service" (p. 356). They found that "for students with low GPAs, the use of campus facilities is correlated with continuance in school" (p. 361). Unfortunately, they were interested in looking at campus facilities holistically and did not separate out the impact of the library or any other service in their analysis.

Not all studies were positive. Ayres and Bennett (1983) studied institutional factors "including library facilities, financial resources, curriculum design, student body attributes, and faculty quality" and found that "no measure of library facilities is strongly related to achievement difference" (p. 521). The authors went on to state, "absence of a strong relationship is, however, more an indictment of the aggregate measure than an indication of the unimportance of books. We really need to know what kinds of books are available and how often they were used by individual students, rather than the total number of books sitting on library shelves. Unfortunately, that information is not available" (pp. 521-522). Their library indicators "used the number of books, number of periodicals, and annual book acquisition budget" (p. 520).

The Association of Research Libraries regularly produces SPEC Kits, which "help libraries learn about current practice in research libraries, implement new practices and technologies, manage change, and improve performance" (Association of Research Libraries, 2010b, p. 1). In late 2010, ARL completed a SPEC Kit on impact measures.

Based upon the framework developed by Poll and Payne (2006), the survey found that "despite the urgency the library community has felt in recent years to justify its value, the responding libraries reported shockingly little work that focuses on investigating whether use of library resources correlate with measures of success for library users" with only 34% of respondents having conducted research on their library's impact (Koltay & Li, 2010, p. 9). Still, though the numbers remain small, they indicate a growing awareness at individual libraries of the need to justify the library's impact.

The Academic Library and Academic Integration

Student engagement is a major factor in student success and persistence. Chickering and Gamson (1991) developed their *Seven Principles for Good Practice in Undergraduate Education* based upon 50 years of educational research. Two of the principles that promote success are *contact* with faculty and *cooperation* among students. Astin (1993) noted that *involvement*, especially with peers and faculty in the pursuit of education, is critical to student success. In their two exhaustive landmark review of college affects students, Pascarella and Terenzini (1991, 2005) found that *integration*, *involvement*, and *interaction* (along with academic performance) improved persistence. In a review of the literature entitled "What Matters to Student Success," Kuh, Kinzie, Buckley, Bridges, and Hayek (2006) found that, along with the characteristics students bring with them to college such as gender, race and ethnicity, academic preparation, educational aspirations, and socioeconomic status (SES), student *engagement* was the single most important factor in student success and Experience. Though they use different terms, these literature reviews each found that student engagement was among the most critical factors to their success in college.

There are only a handful of studies that connect the library to student engagement. Kuh, Boruff-Jones, and Mark (2007a) reviewed the literature on student engagement and explored the conditions under which librarians can engage students. They defined engagement simply as "the more students do something, the more proficient they become" and examined the library's role in light of two features: "the amount of time and effort students put into their studies" and "how a school deploys its resources" (p. 18). They argued that libraries could promote student engagement by minimizing library anxiety, involving librarians in first year programs, and meeting with students outside of class time. They then focused on approaches to teaching information literacy skills to first year students.

Kuh and Gonyea (2003) used data from the College Student Experiences Questionnaire (CSEQ) to analyze the relationship between academic libraries and student learning. Though they found that "on balance, library experiences do not seem to be directly related to information literacy, overall gains in college, or satisfaction with the college experience" (2003, p. 9), they went on to highlight correlations between library indicators and other measures of success that suggest that there might be indirect relationships. Of particular interest was the relationship between academic challenge and library use.

Mark and Boruff-Jones (2003) analyzed the National Survey of Student Engagement (NSSE) in order to develop a process for local academic libraries to use in analyzing and setting benchmarks for their library instruction programs. Their particular interest was to correlate survey questions from the NSSE with the *ACRL Information Literacy Competency Standards for Higher Education*.

Gratch-Lindauer (2008) reported on a project to include ten experimental questions related to information literacy behaviors on the 2006 NSSE. An analysis of the results corroborated that eight of the ten questions showed moderate to high correlations between information literacy scales and NSSE questions.

Earlier, Nelson-Laird and Kuh (2005) had conducted a similar NSSE study with experimental questions about the use of information technology. Several of their questions asked about using technology to obtain resources for academic work, accessing the library (or web), making judgments about the quality of information, or asking a librarian a question (though this last was dropped from the analysis). Overall, they found a moderate to strong "positive relationships between academic uses of information technology and engagement, particularly academic challenge, student-faculty interaction, and active and collaborative learning" (p. 230).

Together, these studies demonstrate positive but most likely indirect correlations between the library and student engagement.

Persistence and Higher Education

Whereas persistence is little studied in the academic library world, it is one of the most studied phenomena in higher education. Pascarella and Terenzini (1991) reviewed "roughly 2,600 pieces of research" (p. xi) on the influence of college upon students. They devoted an entire chapter of their book listing hundreds of studies about *educational attainment*, a category essentially equivalent to persistence. They wrote a follow up with another decade of research, citing nearly as many studies in one decade as in the previous two decades combined (Pascarella & Terenzini, 2005). Once again, they devoted a whole chapter adding hundreds of studies to educational attainment.

Tinto (2006-2007), one of the pioneers in student persistence, reviewed the history of student retention research. He noted, "40 years ago, student attrition was typically viewed through the lens of psychology. Student retention or the lack thereof was seen as the reflection of individual attributes, skills, and motivation" (p. 2). He then tracked the addition of the environment as an influential factor and his own role in developing a longitudinal model that emphasized the student's integration into the environment. Much subsequent work built upon his model and his idea of integration in what he terms the "age of involvement" (p. 3) with studies focusing on the importance of involving the student in the life of the college, especially in the first year. He then described the maturing of the field of retention research with a fine-toothed focus on different types of institutions and students from different backgrounds.

Building upon the work of Pascarella and Terenzini (1991, 2005), a prior review he had written (Reason, 2003), and the review written by Tinto (2006-2007), Reason (2009) thoroughly reviewed the literature on student persistence in higher education. Using a framework he created with Terenzini (Terenzini & Reason, 2005), he examined research published in the areas of student precollege characteristics and experiences, the organizational context, and the peer environment that includes individual student experiences in and out of class.

These reviews of the literature reveal (1) persistence is a much-studied phenomenon in higher education and (2) very few of the studies they cite involve the library's impact on persistence.

Persistence Theories and Models

Persistence models tend to emerge from the work of Tinto, Astin, and Bean. Tinto's model, first developed in 1975 and revised in 1987 and 1993, has now become a standard (Tinto, 1975, 1987, 1993). Tinto developed a model of student departure based on anthropological theories of rites of passage and Durkheim's sociological theories of suicide. His model (Tinto, 1993, p. 114) is longitudinal and includes pre-entry attributes, goals/commitments, and formal and informal academic and social institutional experiences that lead to both academic and social integration, which impact a student's decision to depart.

Astin (1977, 2001) developed the widely used I-E-O model – which is spelled out as Inputs → Environment → Outcome – as a conceptual framework.

> *Inputs* refer to the characteristics of the student at the time of initial entry into the institution; *environmental* refers to the programs, policies, faculties, peers, and educational experiences to which the student is exposed; and *outcomes* refers to the student's characteristics *after* exposure to the environment. (Astin, 1993, p. 7)

Astin's (2001) work is based on "135 college environmental measures and 57 "student involvement" measures" (p. xii) that have been demonstrated to influence the student college experience.

Bean and Metzner (1985, p. 491) developed a model for student attrition that incorporated student background, academic and environmental variables, academic and psychosocial outcomes, and the intent to leave as factors that influenced student dropout rates.

Cabrera, Nora, and Castañeda (1993) concluded that two retention theories provided validated models: Tinto's (citing the 1987 edition) *Student Integration Model* and the Bean and Metzner (1985) *Student Attrition Model*. In this article, they merged the two models in order to better understand student persistence in college. They used structural equation modeling to determine that the integrated model provides a better understanding of persistence. Particularly strong individual, institutional, and environmental indicators in a community college include intent to persist, GPA, institutional commitment, encouragement from friends and family (and these last three factors all influence the factor of intent to persist).

The Model

The Cabrera, Nora, and Castañeda (1993) model seems to be the most cited and most used in subsequent studies. I adopted and adapted the Cabrera, Nora, and Castañeda (1993) model by fitting in library indicators. Model 1 illustrates their model with the addition of the library construct (see Figure 4). Numerous studies show a relationship between the academic library and persistence (Emmons & Wilkinson, 2011; Hamrick, et al., 2004; Kramer & Kramer, 1968; Mallinckrodt & Sedlacek, 2009; Mezick, 2007). But as the relationship is most likely indirect, I hypothesized direct relationships between the library and both academic performance (Bolt, 1986; Dickenson, 2006; Ferguson, 2000; Julien & Boon, 2004; Knapp, 1966; Whitmire, 1998, 2002; Zhong & Alexander, 2007) and academic integration (Gratch-Lindauer, 2008; Kuh, et al., 2007a; Kuh & Gonyea, 2003; Mark & Boruff-Jones, 2003; Nelson-Laird & Kuh, 2005; Rushing & Poole, 2002; Wilder, 1990).

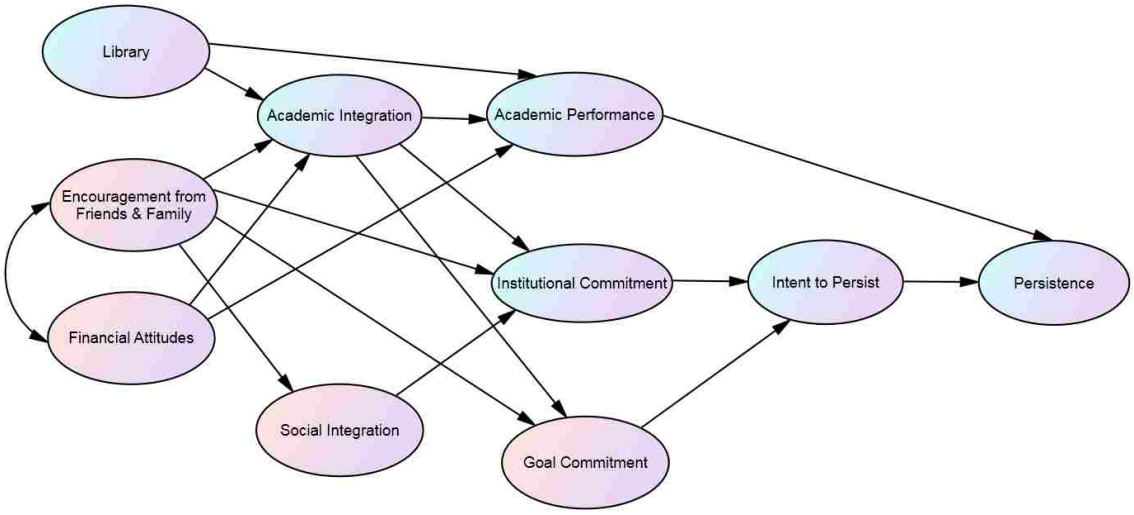


Figure 4: Model 1 - Cabrera, Nora, and Castañeda model (1993) with addition of LIBRARY construct based on Tinto's student integration model (1987, 1993) and Bean & Metzner's student attrition model (1985) Blue indicates the parts of the model impacted by the LIBRARY construct.

Because I have not found any literature that shows the library has more than a negligible impact upon attitudes or social integration, I tested a subset of the model as illustrated in Model 2 (see Figure 5), fitting the model using structural equation modeling.

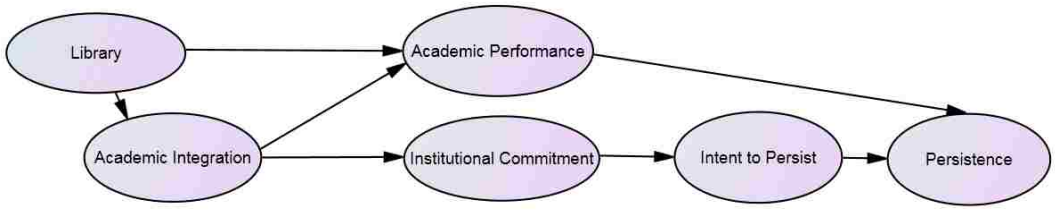


Figure 5: Model 2, A subset of Model 1 - Subset of Cabrera, Nora, and Castañeda model (1993) with addition of library construct based on Tinto's student integration model (1987, 1993) and Bean & Metzner's student attrition model (1985)

CHAPTER 3:

RESEARCH DESIGN

The purpose of my study was to examine the relationship of the academic library to student persistence. I took two approaches: structural equation modeling and multiple linear regressions. My primary approach was hypothesizing and statistically testing a structural equation model that posited indirect relationships between library resources and services to student persistence. The model I fashioned added a library construct to the persistence model developed by Cabrera, Nora, and Castañeda (1993). Their model validated and combined two of the three most cited models, which are Tinto's student integration model (1987, 1993) and Bean & Metzner's (1985) student attrition model – the third is Astin's (1977, 1993) I-E-O model. The Cabrera, Nora, and Castañeda (1993) model has now also become among the most cited models. I used Cabrera, Nora, and Castañeda's structure and basic constructs, but I used different indicators for two reasons: (1) I conducted a multi-institution analysis, which (2) required me to use existing data instead of applying the local survey Cabrera, Nora, and Castañeda (1993) used at their institution. Because there have been few if any studies demonstrating library impact upon attitudes or social integration, I fit only the subset of the model as illustrated in Figure 6.

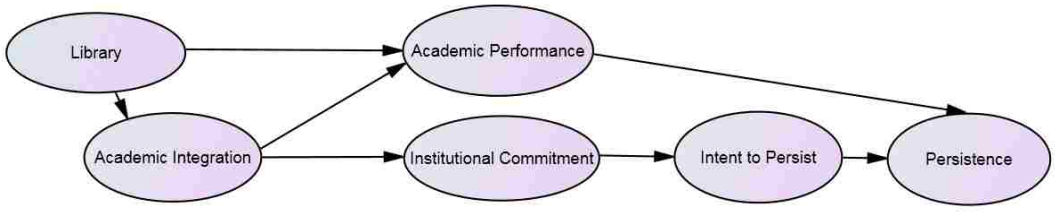


Figure 6: Model 2 - Subset of Cabrera, Nora, and Castañeda model (1993) with addition of LIBRARY construct based on Tinto's student integration model (1987, 1993) and Bean & Metzner's student attrition model (1985)

My model theorized that library input and output measures serve as indicators in a library construct that have a direct impact upon the constructs of academic integration and academic performance and an indirect impact upon persistence. The purpose of my study was to test a model that includes the library as a construct, allowing me to place the library in a model of student persistence.

The model developed by Cabrera, Nora, and Castañeda (1993) was based on institutional data combined with a questionnaire given to individual students at single "large southern urban institution" (p. 129). The model I hypothesized for this study functioned at the institutional level by using existing data from three national surveys: Integrated Postsecondary Education Data System (IPEDS) (National Center for Education Statistics, 2006), Academic Libraries Survey (ALS) (National Center for Education Statistics, 2008a) , and the National Survey of Student Engagement (NSSE) (National Survey of Student Engagement, 2006). The sample was a census in that it included all NSSE participating institutions that also provided complete data to ALS and IPEDS.

Instruments

IPEDS: Integrated Postsecondary Education Data System

I extracted year-to-year retention and six-year graduation rates indicators from the 2006 Integrated Postsecondary Education Data System (IPEDS) (National Center for Education Statistics, 2006). Beginning in 1986, IPEDS began collecting college and university data covering "institutional characteristics, completions, employees by assigned position, salaries, fall staff, enrollment, student financial aid, finance, and graduation rates" (p. iii).

In 2002/2003, IPEDS staff set out to evaluate the quality of the instrument, which had collected data via the web for the first time that year. Their goal was to measure consistency; they did not address accuracy or reliability. They found that the results of their study "tend to confirm the perception that IPEDS is the most comprehensive data system available for information related to postsecondary education" (p. ix). In his overview on the adequacy of a range of higher education data sources, Brint (2002) confirmed that the IPEDS data "are among the most comprehensive data on institutional characteristics and institutional activities" but that the "data, though good for the majority of institutions, are not completely valid" (p. 1497).

ALS: Academic Libraries Survey

I took library input and output indicators from the 2006 Academic Libraries Survey (ALS) (National Center for Education Statistics, 2008a). Since 1966, the U.S. Census Bureau has collected data on behalf of the National Center for Education Statistics (NCES) from academic libraries on materials, staff, hours, and facilities. The 2006 report includes "descriptive statistics for approximately 3,600 academic libraries" (National Center for Education Statistics, 2008b, p. 1) from throughout the United States. That year, NCES surveyed all 3,617 academic libraries and had an overall response rate of 88.8% (p. 4). Missing data was filled in with prior year data adjusted if needed or imputed by the median cell distribution ratio.

In 1999, NCES closely examined the ALS survey in order to determine the accuracy and reach of their coverage. They noted that their "findings suggest that the data collected represent a high quality product when compared to other surveys within the same field of study" (National Center for Education Statistics, 2008b, p. 3) and that their

survey "is the most comprehensive data source for academic libraries data of its kind in the United States" (p. 3). The NCES did not address the validity or reliability of the instrument. Brint (2002) noted that the ALS "response rates are high and data quality is excellent" (p. 1501).

NSSE**: National Survey of Student Engagement**

NSSE data were used with permission from the Indiana University Center for Postsecondary Research. I purchased data to create the indicators for academic integration, academic performance, institutional commitment, and intent to persist from the administrators of the 2006 National Survey of Student Engagement (NSSE) (National Survey of Student Engagement, 2006). At the same time, I obtained data to create the indicators of library engagement asked as experimental questions during that same 2006 NSSE.

NSSE measures student engagement and the "extent to which different colleges exhibit characteristics and commitments known to be related to high-quality undergraduate student outcomes" (Kuh, 2001, p. 3). These characteristics are based on Pace's theory of student effort (Pace, 1984) and Chickering and Gamson's *Seven Principles of Good Practice in Undergraduate Education* (1991). The 42 original questions asked by NSSE were based upon face validity as well as established and validated measures including UCLA's *Cooperative Institutional Research Program* (CIRP), Indiana University's *College Student Experiences Questionnaire* (CSEQ), and surveys developed at the University of North Carolina (Kuh, 2001). In subsequent years, NSSE has evolved. In 2006, the survey included 14 questions with 85 sub-questions plus 13 demographic questions.

The items on the NSSE questionnaire are grouped into "five benchmarks of effective educational practice": level of academic challenge, active and collaborative learning, student interactions with faculty members, enriching educational experience, and supportive campus environment (Kuh, 2001, p. 5). The benchmarks "were created with a blend of theory and empirical analysis" (Kuh, 2001, p. 30).

Researchers shared results of the inaugural 2000 NSSE *College Student Report* covering the survey design, project goals, and potential uses and analyzing the data from the first national administration of the test for validity and reliability (Kuh, 2001). The estimates of Cronbach's Alpha, a reliability coefficient that calls for a minimum score of .7 to be considered reliable, ranged from .79 to .83 for each benchmark. In summary, "the pattern of responses from first-year students and seniors suggest the items are measuring what they are supposed to measure" (Kuh, 2001, p. 15). Though the names of the benchmarks have changed in subsequent years to match the five categories mentioned in the paragraph above, the original reliability scores were good. The 20 *College Activities* items score was .82. For questions related to higher order thinking skills, the estimate of Cronbach's Alpha was .79. For *Educational and Personal Growth* items, the estimate of Cronbach's Alpha was .88. For *Opinions about your School*, the estimate of Cronbach's Alpha was .83.

Researchers also conducted focus groups to get a grasp on how students interpret the questions (Kuh, 2001; Ouimet, Bunnage, Carini, Kuh, & Kennedy, 2004). Kuh found that "students interpreted the response categories on *The College Student Report* in similar ways" (p. 34). Interested in developing measures that colleges and universities could use locally at the college or department level to assess student learning and make

changes, Pike (2006b) recombined NSSE items to develop alternative measures to the benchmarks. He called these scalelets, which "consist of a limited number of survey questions that provide a measure of a specific aspect of the educational experiences of a group of students" (p. 181). He developed 12 scalelets: course challenge, writing, higher-order thinking skills, active learning, collaborative learning, course interaction, out-of-class interaction, varied experiences, information technology, diversity, support for student success, and interpersonal environment. All scalelets had acceptable generalizability coefficients ($Ep^2 \geq .70$). In a related study published later the same year, Pike (2006a) demonstrated that the scalelets he developed "provide valid measures of students' educational experiences and can be used for institutional assessment and improvement" (p. 558) and that "the relationships between engagement and outcomes were more nuanced for scalelet scores than for the NSSE benchmark scores" (p. 559). Pike believed that "scalelet scores are most useful to academic affairs, student affairs, and assessment professionals who are charged with taking NSSE results and translating them into a series of actions items to improve student experience on campus" (p. 559). He also argued that "scalelets can also be constructed for institutions using locally developed surveys" (p. 560).

LaNasa, Cabrera, and Trangsrud (2009) fit a structural equation model to examine relationships among the student engagement test items that make up the benchmarks. They found that many of the measures in the five factor interdependent model either lacked explanatory power or were not independent, and that while estimates of Cronbach's Alpha reliability coefficient demonstrated high reliability and internal consistency, there were significant item-level errors. They therefore used exploratory and

confirmatory factor analysis to develop an alternative model with nine dimensions: (1) learning strategies, (2) academic interaction, (3) institutional emphasis, (4) co-curricular activity, (5) diverse interactions, (6) effort, (7) overall relationships, (8) workload, and (9) working collaboratively in-class.

Subsequent studies have for the most part confirmed the construct validity and reliability of the various items, benchmarks, and scales that have emerged from the NSSE, though usually with somewhat lower generalizability scores.

Carini, Kuh, and Klein (2006) compared NSSE benchmarks to a series of cognitive and performance measures designed by RAND to measure critical thinking along with SAT scores and GPA at 14 varied institutions. They found valid constructs for the level of academic challenge ($\alpha = .70$), student-faculty interaction ($\alpha = .71$), and supportive campus environment ($\alpha = .75$), but not for active and collaborative learning ($\alpha = .62$) or enriching educational experiences ($\alpha = .56$). They also developed ten additional sub-scales based on NSSE items for a total of fifteen. Eleven of the 15 were valid and of these, "very modest but statistically significant positive partial correlations were found for 9 of the 11 engagement scales" (p. 13). With the RAND and GRE tests and student GPA as dependent variables, a regression analysis found that "these 11 engagement measures explained 2.9, 1.3, and 3.1% of the variance in the residuals for RAND, GRE, and GPA, respectively" (p. 13) with no single benchmark providing more than 2% explanation of the variance. Most interesting is that "low ability students benefited more from engagement than high ability counterparts" (p. 16). In other words, engagement has a statistically significant, but small effect, on critical thinking and grades, with low ability students benefiting the most from engagement.

Gordon, Ludlum, and Hoey (2008) administered the NSSE to students at Georgia Tech and compared NSSE benchmark scores against the indicators of student success of "cumulative GPA, first-year retention, job attainment upon graduation, and the decision to pursue a graduate degree" (pp. 23-24). They found that the overall reliability of the benchmarks was lower at Georgia Tech than for national NSSE scores, with estimates of Cronbach's Alpha reliability coefficient slightly below .7 for every benchmark except supportive campus environment – it is important to note, however, that their measures applied to the institutional level while the national scores applied to the student level. Ultimately, they found that the NSSE benchmarks provided minimal predictive value for GPA, retention, job attainment, or graduate school. Consequently, they tested Pike's 12 derived scalelets. Once again, the estimates of Cronbach's Alpha reliability coefficient were lower, demonstrating less internal consistency. Despite the low estimates, they chose to pursue the analysis at Georgia Tech and found that "while the scalelets are not as psychometrically reliable as the NSSE benchmarks, they do represent a modest improvement in predicting student outcomes at Georgia Tech" (p. 32). They found that selected individual NSSE items provided the most significant explanatory power.

Carle, Jaffee, Vaughan, and Elder (2009) used NSSE items to develop three new constructs of student engagement: transformational learning, community-based learning, and student-faculty interactions. Using item response theory and confirmatory factor analysis, the researchers verified that the items from the NSSE measured each of the three constructs well and that the three constructs were indeed separate.

Pascarella, Seifert, and Blaich (2010) examined the relationship between NSSE and the Wabash National Study of Liberal Arts Education (WNSLAE). WNSLAE is a

test that measures the institutional experiences that promote student success in liberal arts colleges with five dimensions: (1) effective reasoning and problem solving, (2) moral character, (3) inclination to inquire and lifelong learning, (4) intercultural effectiveness, and (5) personal well-being. Though the sample was small with only 19 institutions represented, the researchers conducted a pre- and post-test to estimate associations. They found that "at least one of the NSSE benchmarks has a significant partial association with each of the end of first-year liberal outcomes except the Need for Cognition scale" (p. 10). Due to the small sample size, the authors cannot generalize, but nevertheless cautiously conclude that their findings "lend support to the claim that the NSSE benchmarks do in fact measure institutional practices and student experiences that are precursors to growth in important educational outcomes such as critical thinking, moral reasoning, intercultural effectiveness, personal well-being, and positive orientation toward literacy activities" (p. 12).

Not all studies have found NSSE to be valid and reliable. Investigators at James Madison University wanted to know whether the NSSE was worth using to make policy and program changes, so they decided to test its construct validity (Swerdzewski, Miller, & Mitchell, 2007). They found that "the five factor benchmark model supported by NSSE was not upheld" (p. 16) and that they should not make decisions based on the model. Porter (2006) argued that the NSSE lacks validity because it is based more on empirical research than on a theoretical framework, that it incorrectly assumes that college students can understand questions and accurately remember and self-report behaviors and attitudes, and that "much of the evidence that higher education scholars cite as evidence of validity and reliability actually demonstrates the opposite" (p. 3),

meaning in the case of the NSSE that researchers have accepted dubious measures of validity and reliability by using internal measures. Porter's (2006) main criticism, however, is the unreliability of self-reporting.

Constructs and Indicators

I obtained observed measures for the underlying latent constructs in the model from three national surveys: Integrated Postsecondary Education Data System (IPEDS) (National Center for Education Statistics, 2006), Academic Libraries Survey (ALS) (National Center for Education Statistics, 2008a) , and the National Survey of Student Engagement (NSSE) (National Survey of Student Engagement, 2006). See Appendix A for the codebook listing all variables.

Library

The library construct is indexed by inputs and outputs that have demonstrated a relationship with persistence. Mezick (2007) found a statistically significant correlation between total library expenditures, total library materials expenditures, and serial expenditures, and library professional staff with student persistence. Hamrick et al. (2004) found that increasing total library expenditures provided a statistically significant explanation of graduation rates. Emmons and Wilkinson (2011) confirmed the correlations that Mezick identified between expenditures and persistence and also correlated persistence with total materials circulated and the percentage of students reached by instruction; in addition, they found that a change in the ratio of library professional staff to students predicted a statistically significant positive relationship with both retention and graduation rates. The indicators for the library construct include:

- Ratio of professional library staff to students: percentage (ALS divided by IPEDS data for total FTE undergraduate students)
- Total library expenditures; dollars (ALS)
- Total materials circulated: numbers (ALS)
- Total students reached by instruction: numbers (ALS)

I also tested an alternate set of indicators for the library construct that controlled for institution size by calculating the ratio to FTE undergraduate students (enrollment figures were from IPEDS). The alternate indicators for the library construct include:

- Ratio of professional library staff to students: percentage (ALS divided by IPEDS data for total FTE undergraduate students)
- Library expenditures per student; dollars (ALS divided by IPEDS data for total FTE undergraduate students)
- Materials circulated per student: numbers (ALS divided by IPEDS data for total FTE undergraduate students)
- Percentage of students reached by instruction: percentage (ALS divided by IPEDS data for total FTE undergraduate students)

Library Engagement

Library Engagement measures consist of an experimental questionnaire that NSSE included in their 2006 administration called the Information Literacy Test (ILT) (Gratch-Lindauer, 2008). I had originally planned to fit a second model using the ILT questions as indicators for the library construct, but only 33 institutions participated, a sample size far too small for structural equation modeling or a multiple linear regression analysis. See Appendix B for a discussion of the indicators and their estimated

correlations with the observed measures I used in this study. I return to a discussion of these measures in the section on future research in Chapter 5.

Academic Performance

The observable measures for the Academic Performance construct index achievement and higher order thinking skills. In addition to grade point average (GPA), performance can be indicated by the use of higher order thinking or deep processing skills. Fenollar, Román, and Cuestas (2007), for example, found a statistically significant correlation between deep processing and academic performance, so I have included the item on the NSSE that asks about higher order thinking skills to create a scale called Bloom's Taxonomy. In addition, NSSE asks students how the institution has contributed to their ability to think critically and learn on their own. The indicators for the academic performance construct include:

- What have most of your grades been up to now at this institution? (choices include fractionated grades from A, A-…C, C- or lower) (NSSE)
- During the current school year, how much has your coursework emphasized the following mental activities? (very much, quite a bit, some very little) (NSSE)
    - Memorizing
    - Analyzing
    - Synthesizing
    - Making judgments
    - Applying
- To what extent has your experience at this institution contributed to your knowledge, skills, and personal development in the following areas?

- Thinking critically and analytically
- Learning effectively on your own

Academic Integration

The indicators for Academic Integration measure the extent to which students are content with their academic life and the degree to which they are involved in and challenged by academic activities. I used Pike's (2006a, 2006b) scalelets as indicators:

- course challenge
- active learning
- collaborative learning
- course interaction

Institutional Commitment

Institutional commitment is defined as the overall allegiance students have to their institution and the people with whom they interact. I used three indicators from NSSE and Pike's support for student success scalelet. Indicators for the institutional commitment construct include:

- Mark the box that best represents the quality of your relationships with people at your institution (seven point Likert scale) (NSSE)
  - Relationships with other students (1. unfriendly, unsupportive, sense of alienation to 7. friendly, supportive, sense of belonging)
  - Relationships with faculty members (1. unavailable, unhelpful, unsympathetic to 7. available, helpful, sympathetic)
  - Relationships with personnel and offices (1. unhelpful, inconsiderate, rigid to 7. helpful, considerate, flexible)

- Support for student success

Intent to Persist

The Intent to Persist construct captures the notion of a student's intention to stay in school. There are two items in the NSSE survey that indirectly address the intent to persist. Indicators for the intent to persist construct include:

- If you could start over again, would you go to the *same institution* you are now attending? (definitely yes, probably yes, probably no, definitely no) (NSSE)
- How would you evaluate your entire educational experience at this institution? (excellent, good, fair, poor) (NSSE)

Persistence

Persistence is the likelihood that a student will continue attending school and graduate. Indicators for the intent to persist construct include:

- First to second year retention rates (IPEDS)
- Six year graduation rates (IPEDS)

Limitations of the Study

As in any structural equation model, the observed measures may be imperfect in terms of tapping into or defining the phenomenon I wished to examine. Of most concern was the use of input and output measures to serve as library indicators for the library construct. Though the input and output measures I selected to serve as library indicators have been shown to correlate or predict student retention and graduation rates, they do not measure the quality of interactions with students. The number of librarians, the total expenditures, the amount of materials circulated, and the number of classes taught, whether controlling for the size of the institution or not, do not tell us how engaged those

librarians may be with students or if students make good use of the books they check out. The NSSE experimental library items were designed to get at issues of student engagement with the library, but there were too few participating institutions to conduct the type of analysis that interested me.

Another potential limitation of my study was the use of NSSE items as indicators in place of the questions that Cabrera, Nora, and Castañeda (1993) used in their model. Though NSSE items were designed to measure the same type of issues, the questions were different.

Finally, my sample was at the institutional level while the original Cabrera, Nora, and Castañeda (1993) study was at the individual level. Connections and relationships at the individual level may be lost when figures are aggregated at the institutional level.

Sample

The unit of measure was the institution. Institutions included four-year colleges and universities. Because individual students take the NSSE survey, I used mean data for each institution. The sample was a census in that it included every institution that participated in the NSSE survey in 2006 (525 in all) that also contributed to the IPEDS (6,622) and ALS (3,925) surveys. Only 33 institutions participated in the NSSE experimental Information Literacy Test in 2006.

Data Collection

I collected the data from IPEDS and ALS, which is freely available on the Web, and loaded the data into SPSS statistical software (IBM, 2012b). I purchased the data from NSSE. A data analyst at NSSE aggregated the responses to each question at the institutional level. She required me to collapse my library and persistence data from ALS

and IPEDS before she would merge the NSEE data with mine. NSSE promises anonymity to participating institutions. In order to make sure that researchers cannot identify individual institutions, they ask that any data from files they merge to theirs cannot be linked back by matching unique variable values to cases. NSSE requires that no case can have a unique value and that at least four cases share the same value. For example, in the sample there existed only one library that had circulated over 2,000,000 books, two that had spent over $40,000,000, and three that graduated under 10%, so I needed to group those institutions into sets of at least four cases with identical values for each variable. I accomplished this by either taking the average or rounding to the nearest whole number depending upon the variable. This tended to impact the numbers at the low and high ends of the scales the most. After completing this task, it then became impossible for me to use any unique number such as total library expenditures or number of classes taught or graduation rate to identify an individual institution.

After I collapsed the data, NSSE supplied individual student data aggregated at the institutional level for all of the questions I requested, including the mean, median, and mode, the frequency of response in each category, the minimum and maximum, the standard deviation, and the skewness and kurtosis. From the resulting sample, I removed cases that were missing data for the library or persistence measures.

Data Analysis

I used two books to inform my data analysis: *Principles and Practice of Structural Equation Modeling* (Kline, 2005) and *Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming* (Byrne, 2010). I used SPSS software (IBM,

2012b) to conduct the data analysis and SPSS AMOS software (IBM, 2012a) to conduct the structural equation modeling.

In Chapter 4, I reported descriptive statistics and described correlation matrices. I investigated and screened the data for multivariate and univariate normality. I transformed scores to improve normality of library measures. I tested for outliers and removed as required. I examined the results for multicollinearity and removed variables that are in essence duplicates of other variables. I checked for internal consistency of the data. I tested the construct validity and reliability of the scores.

Structural Equation Modeling

Structural equation Modeling (SEM) was ideal for this study because it allows a researcher to explore complex models that include multiple and related relationships between constructs. It was particularly useful for my study because the academic library has been shown to correlate with and predict student persistence, but it seems unlikely that the relationship is direct. In fact, the library is only one of among many student and environmental characteristics that influence persistence and it is highly likely that the library is dependent upon and influences yet other mediated factors that lead to persistence. I specified a model based on theory and used SEM to see how well the model fit.

I used SPSS AMOS software to fit the structural equation model I hypothesized and presented in Figures 5 and 6. After conducting the initial data screening as described above, I used the SPSS AMOS computer software to estimate the model following the process recommended by Kline (2005) and Byrne (2010) by evaluating the goodness-of-fit statistics and interpreting the parameter estimates. I also considered a less constrained

model and examined modification indices to respecify the model. I had also planned to conduct a path analysis if the model had fit.

Multiple Linear Regression

I fit a taxonomy of multiple regression models analyzing the relationship between the dependent variable of graduation and the independent variables of the indicators for academic performance, academic integration, institutional commitment, and intent to persist.

CHAPTER 4:

FINDINGS

My study investigated the role the academic library plays in student retention and graduation rates. Because it is unlikely that the library plays more than a minor direct role in retention and graduation, I hypothesized that the library impacts student persistence primarily by influencing students' academic performance and their academic integration. See figure 7 for a detailed look at the relationships that I have hypothesized.

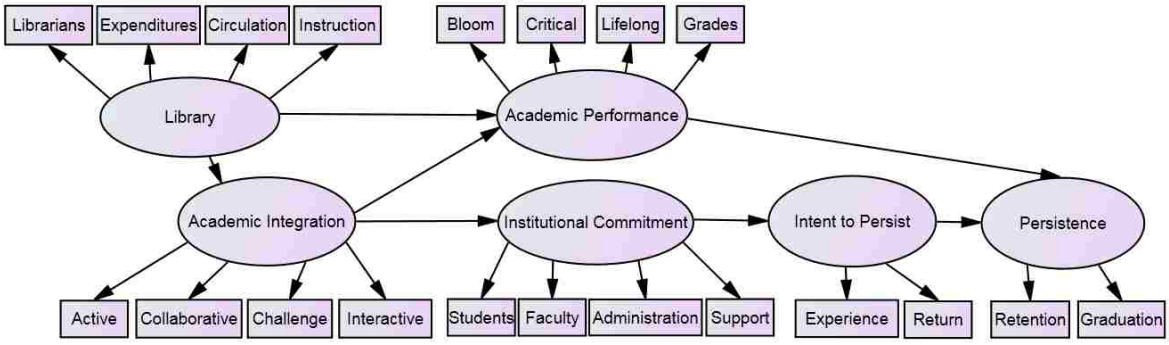


Figure 7: Model 3 – Path Diagram of Model 2 with indicators added

I began my analysis by creating a dataset in SPSS that combined library variables from the Academic Library Survey (ALS), academic performance, academic integration, institutional commitment, and intent to persist variables from the National Survey of Student Engagement (NSSE), and persistence variables from Integrated Postsecondary Education Data System (IPEDS). I then computed the descriptive statistics for each variable, tested the reliability of the Bloom's taxonomy and Pike's scalelets indicators, estimated the correlation matrix of the observed variables, and used SPSS AMOS to test my model.

In this chapter, I have presented the descriptive statistics, the testing and construction of scales, and an analysis of the estimated correlation matrix of the observed

variables followed by the results of the test of the model that include a discussion of the goodness of fit statistics and parameter estimates for both the measurement model and the structural model. I also fit a taxonomy of multiple regression models analyzing the relationship between the dependent variable of graduation and the independent variables of the indicators for academic performance, academic integration, institutional commitment, and intent to persist.

Sample

The level of analysis was institutions. The cases included all institutions that participated in both the 2006 Academic Library Survey (ALS) and the 2006 National Survey of Student Engagement (NSSE) survey. In 2006, 3,925 institutions participated in the ALS and 525 institutions participated in the NSSE; 522 participated in both. Cases with missing retention or graduation rates or library variables were removed. The analytic sample consisted of 497 institutions.

Descriptive Statistics

In the following tables, I have reported the descriptive statistics by construct and provided a brief description of each. I also analyzed the reliability of the scales I used as observed measures. The descriptive statistics that follow were all based on collapsed library and persistence variables and variables defined by NSSE. I described the process of collapsing variables in Chapter 3.

Library Construct

The indicators for the Library construct consisted of input and output measures – librarians per student, expenditures, circulation, and instruction – that have been shown in the literature to have either a statistically significant correlation with or predictive impact

upon student persistence. I extracted the Library indicators from the 2006 Academic Library Survey and collapsed them as described in Chapter 3 in order to be able to combine them with the NSSE indicators and protect the identity of individual institutions.

Academic libraries in the sample varied tremendously. The smallest institutions were one-person operations with small budgets that served few students. The largest academic libraries employed hundreds of librarians and spent millions of dollars serving thousands of students (see Table 1). The variation was so extreme, in fact, that it is likely that each of the Library indicators violated assumptions of normality. Kline (2005, p. 50) indicated that a kurtosis score above 10 and a skewness score above 3 give strong evidence that the univariate variable violates normality, and the library measures all scored above these thresholds.

Table 1:
Library Construct: Descriptive Statistics for Librarians per Student, Total Library Expenditures, Serial Expenditures, Circulation Transactions, and Attendance at Presentations (N = 497)

	Mean	SD	Minimum	Maximum
Librarians ratio	.0033	.0026	.0008	.0385
Library expenditures	$3,179,382	$5,467,000	$99,756	$37,529,545
Library serial expenditures	$828,149	$1,522,000	0	$10,284,965
Library circulation	75,383	156,197	0	1,265,029
Library instruction	3727	5078	0	36,417

Ratio of library professional staff to FTE students. There was great variation in the ratio of library professional staff to students, from .0008 to .0385, with a mean of .0033. In practical terms, this meant that in the sample, the mean number of students served by each professional librarian was 410 students, with the least proportionately staffed libraries serving 1,250 students per librarian and the most proportionately staffed

libraries serving 52 students per librarian. This was extreme variation, as indicated by kurtosis of 16.084 and a skewness of 3.171.

Total library expenditures. Total library expenditures varied greatly. Institutions spent from $99,756 to $37,529,545 (this top figure is an example of collapsing numbers in a variable, as I calculated the mean of the library that spent over $40,000,000 with the three other highest spenders to arrive at this figure). This represented a large variation, as indicated by a kurtosis of 19.397. A skewness of 4.039 indicated a distribution veering to the lower expenditures with a long tail at the high end. In other words, while most institutions averaged lower expenditures, there were a small number of institutions that spent substantially more on their libraries than the rest of the sample.

Expenditures for current serial subscriptions. Libraries in the sample spent an average of $828,149 on current serials, but expenditures varied greatly. One institution did not pay for any journal subscriptions at all, while other institutions spent from $29,687 to $10,284,965 per year. This was a large variance, as indicated by a kurtosis of 14.956 and a skewness of 3.622. Note that the correlation between total expenditures and serial expenditures was statistically significant and very high at .916. This made sense, since expenditures for serials is a subset of total library expenditures. Due to the high degree of collinearity with an estimated correlation coefficient above .85 (Kline, 2005, p. 56), I used only the total expenditures as an indicator for expenditures.

General circulation transactions. Circulation of library materials varied greatly. Two institutions apparently did not circulate materials at all, while other institutions circulated between 1,382 and 1,265,029 items. This was massive variation, as indicated a

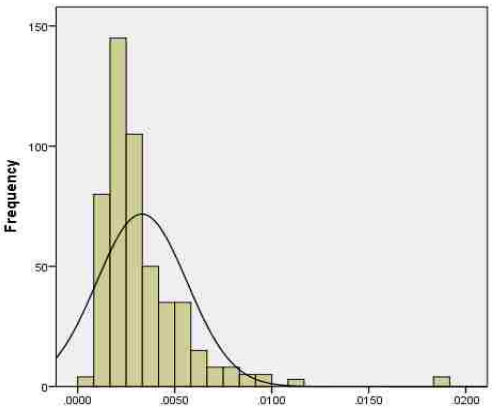
kurtosis of 38.823. A skewness of 5.717 indicated that most libraries circulated fewer items, with a handful of libraries circulating substantially more materials.

Total attendance at all presentations. Librarians taught students how to conduct research and attendance at these presentations varied greatly. Libraries at two institutions apparently did not teach classes at all, while other institutions taught between 55 and 36,417 students that year, with a mean of 3,727. This was a very large variation, as indicated by a kurtosis of 15.475. This variable was highly skewed (3.437), a result that was likely caused by a small number of libraries that teach substantially more students how to conduct research.

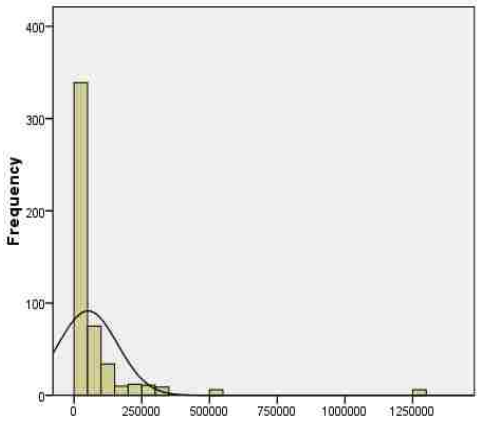
Normality

The library variables for expenditures, circulation, and instruction were all highly skewed, violating assumptions of normality (see figure 8).

Librarians



Circulation



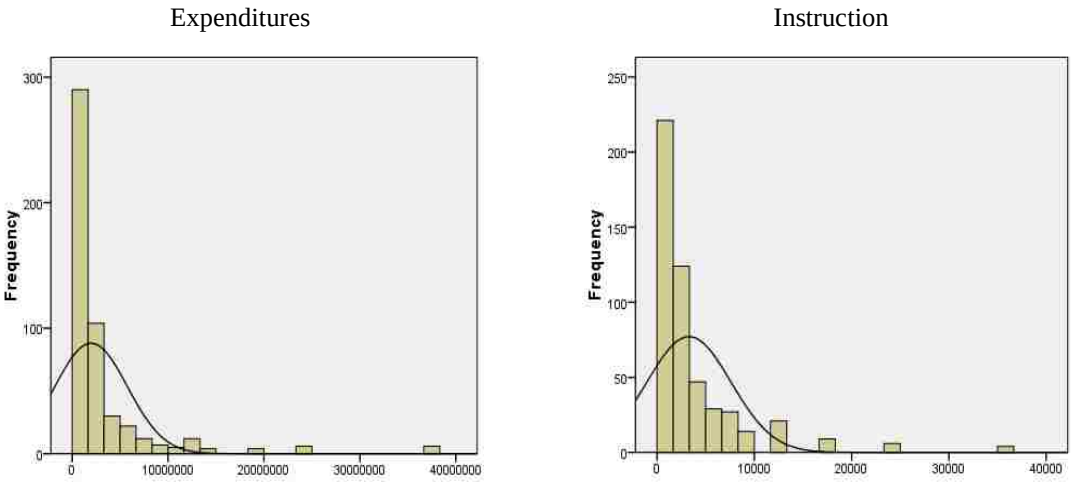
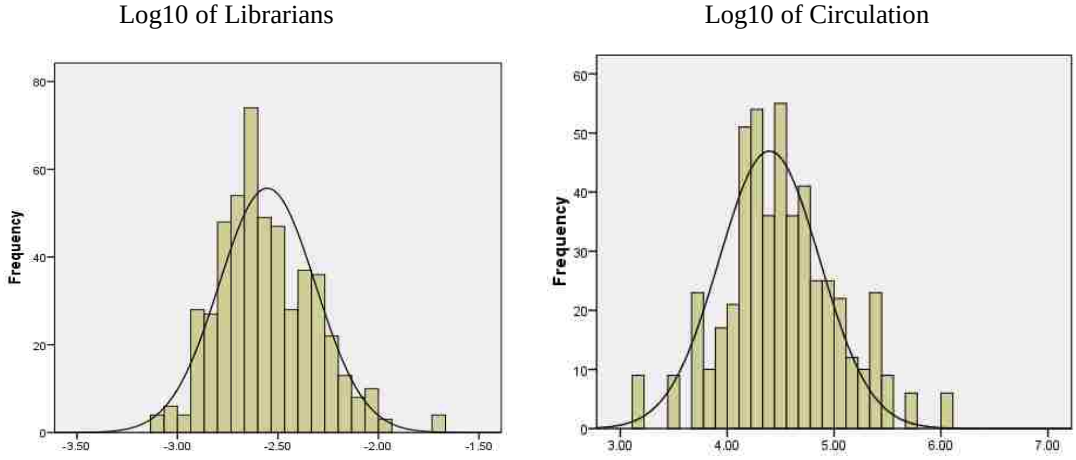


Figure 8: Histograms for Ratio of Librarians, Library Expenditures, Library Circulation, and Library Instruction

Kline (2005, pp. 50-51) recommended normalizing univariate measures that show high kurtosis and skewness in order to avoid committing an error of overestimation or underestimation. I therefore normalized the data by taking a log base 10 of the ratio of librarians, expenditure, circulation, and instruction library variables (see figure 9).



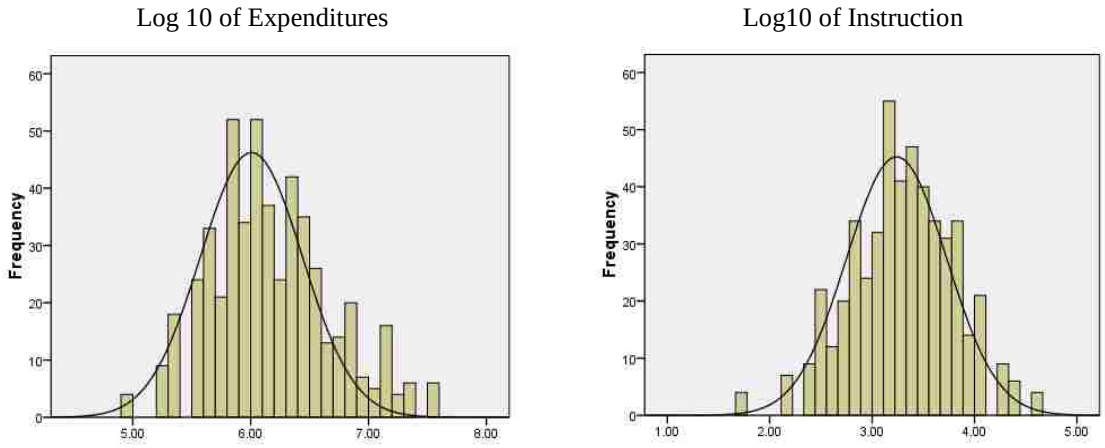


Figure 9: Histograms for Ratio of Librarians, Library Expenditures, Library Circulation, and Library Instruction transformed with Log10

Each of the library variables now demonstrated normality and had measures of kurtosis and skewness that fell below 1.0. The Library construct was therefore represented by the observed measures of Log10 of the ratio of librarians to students and the Log10 for expenditures, the Log10 for circulation, and the Log10 for instruction (see Table 2).

Table 2:
Library Construct: Descriptive Statistics for Log 10 Librarians per Student, Log10 of Total Library Expenditures, Log10 of Circulation Transactions, and Log10 of Attendance at Presentations for the Collapsed Dataset (N = 497)

	Mean	SD	Minimum	Maximum
Log10 of Librarians Ratio	-2.55	.240	-3.10	-1.72
Log10 of Library expenditures	6.18	.503	5.00	7.57
Log10 of Library circulation	4.52	.533	3.14	6.10
Log10 of Library instruction	3.30	.500	1.74	4.56

Library Construct with Alternate Measures

The extreme variation in the size of academic libraries was cause for concern. A large institution with a large budget and larger collections was likely serving more students than a smaller institution with a smaller budget and smaller collections. The variation may only indicate the size of the institution and not the amount allocated to

each student. This was the reason that Emmons and Wilkinson (2011) used the ratio of librarians to students to predict an increase in retention and graduation rates in an earlier study. I therefore converted each of the remaining library measures of total expenditures, circulation, and instruction into ratios and estimated descriptive statistics for these alternative measures. The ratio of professional librarians to students remained the same.

Table 3:
Library Construct with Alternate Measures: Descriptive Statistics for Ratio of Librarians, Total Library Expenditures, Serial Expenditures, Circulation Transactions, and Attendance at Presentations to Total FTE Students (N = 497)

	Mean	SD	Minimum	Maximum
Librarians ratio	.0033	.0026	.0008	.0385
Library expenditures ratio	524.26	348	88.46	2889.26
Library circulation ratio	13	14	0	163
Library instruction ratio	.69	.4112	0	3.37

Ratio of library expenditures to FTE students. There was great variation in the amount each library spent per student, with a low of $139 and a high of $2,211 for an average of $530. This was extreme variance, as indicated by Kurtosis of 23.344. Skewness of 4.299 is considered highly skewed.

Ratio of library circulation to FTE students. On average, libraries circulated 13 items per student. Two institutions apparently did not circulate materials at all. For libraries in the sample that circulate items to their students, the minimum was 0.4 items per student and the maximum was 163 items per student.

Ratio of library instruction to FTE students. On average, 69% of students visited the library once for instruction. Two institutions apparently did not teach classes at all. For libraries in the sample that did teach classes to their students, the lowest reached only 3.4% of their students once during the year while at the highest level, each student came to the library to learn over 3 times during the year. The library variables for ratios of

expenditures, circulation, and instruction were also all highly skewed, violating assumptions of normality (see figure 10).

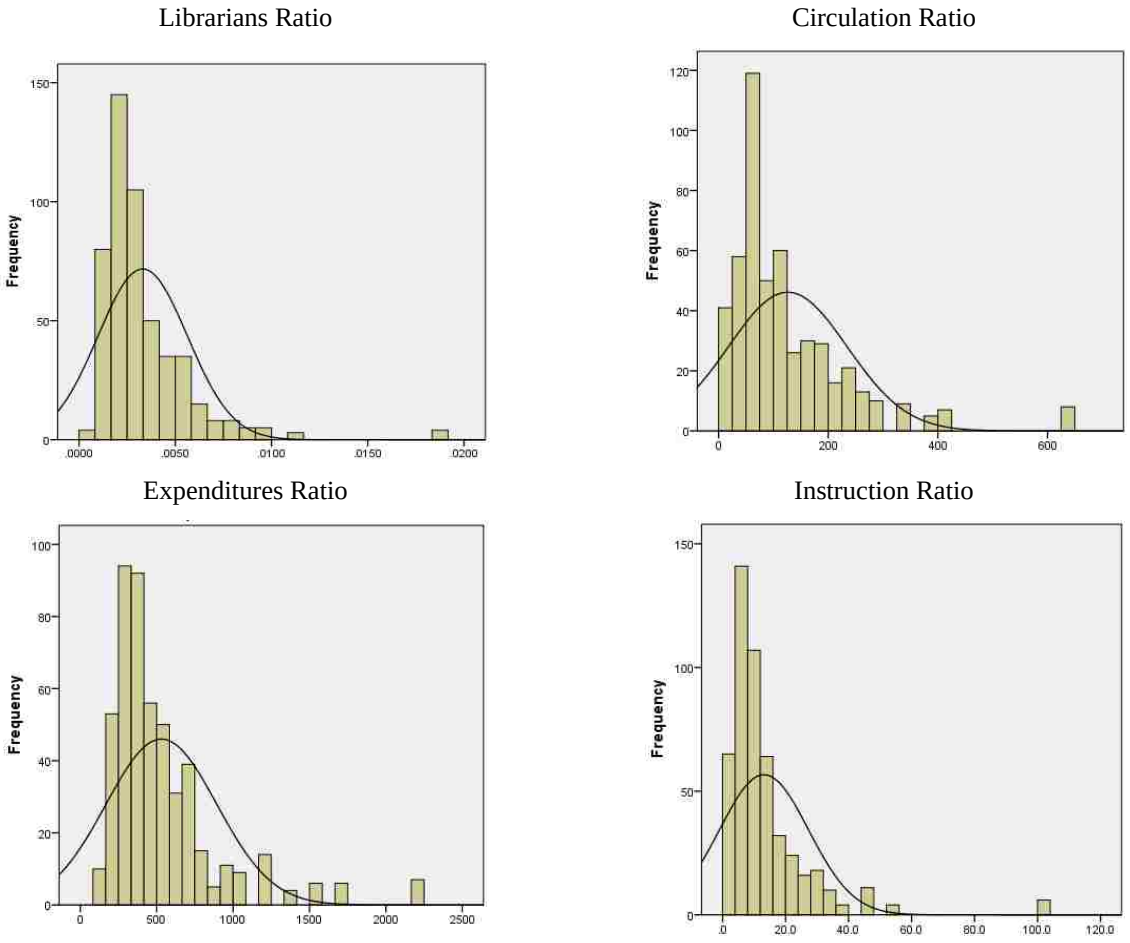


Figure 10: Histograms for Ratio of Librarians to FTE students, Ratio of Library Expenditures to FTE students, Ratio of Library Circulation to FTE students, and Ratio of Library Instruction to FTE students

Once again, in order to avoid committing an error of overestimation or underestimation, I normalized the data by taking a log base 10 of the ratio of librarians, ratio of expenditures, ratio of circulation, and ratio of instruction library variables (see figure 11).

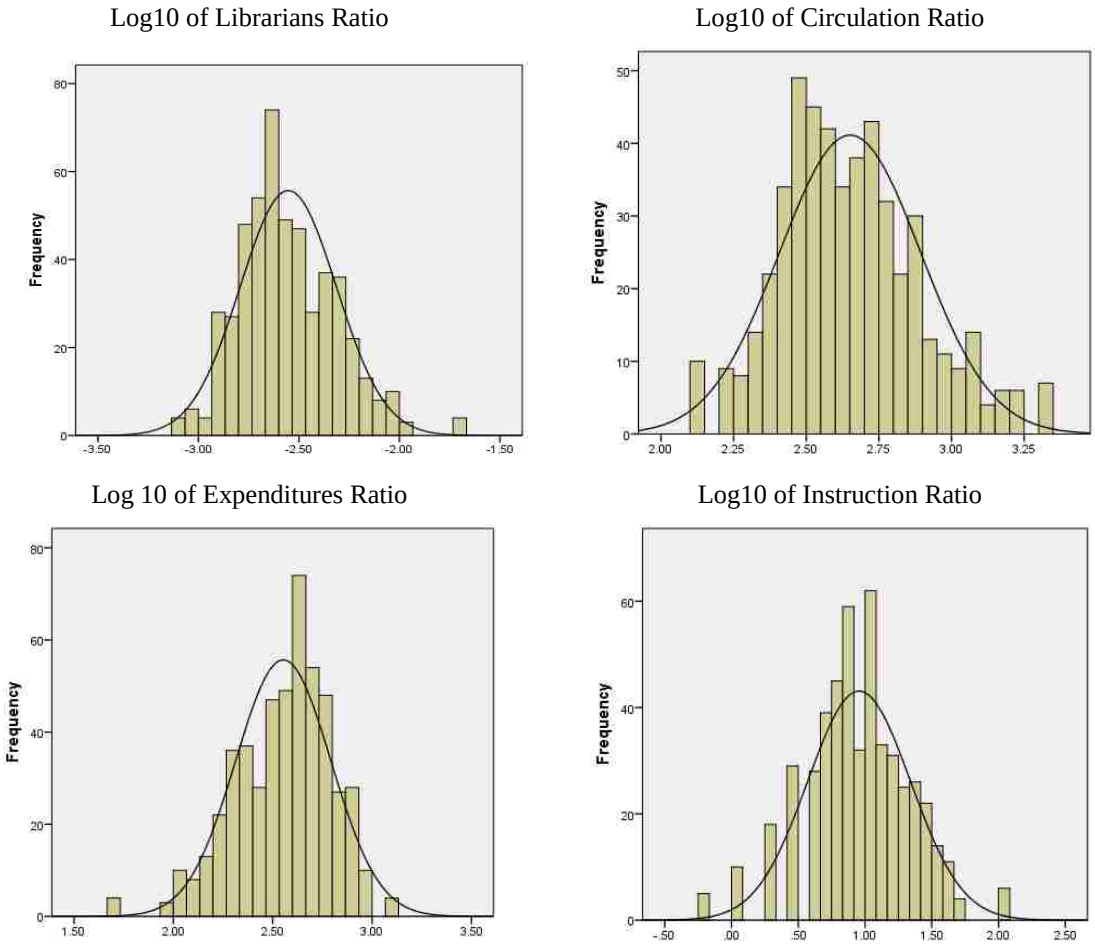


Figure 11: Histograms for Ratio of Librarians, Library Expenditures, Library Circulation, and Library Instruction transformed with Log10

Each of the library ratio variables now demonstrated normality and had measures of kurtosis and skewness that fall below 1.0. The alternate Library ratios construct were therefore represented by the observed measures of Log10 ratio of librarians, expenditures, circulation, and instruction.

Academic Performance Construct

The Academic Performance construct represented the extent to which students at an institution, on average, engaged in higher order thinking skills that lead to critical thinking and lifelong learning, as possibly reflected in their grades. I obtained the Academic Performance indicators from the 2006 NSSE. See Table 4.

Table 4:
Academic Performance Construct: Descriptive Statistics for Memorized, Applied, Analyzed, Synthesized, Evaluated, Critical Thinking, Lifelong Learning, and Grades (N = 497)

	Mean	SD	Minimum	Maximum
Memorized	2.76	.219	1.53	3.25
Applied	3.11	.114	2.57	3.52
Analyzed	3.18	.143	2.70	3.68
Synthesized	2.98	.163	2.46	3.56
Evaluated	2.93	.121	2.52	3.41
Critical thinking	3.30	.146	2.81	3.80
Lifelong learning	2.96	.135	2.58	3.60
Grades	6.00	.371	4.28	7.30

Bloom's Taxonomy

NSSE asked students how much their coursework emphasized each of the cognitive activities – memorization, application, analysis, synthesis, and evaluation – on a four point scale from (1) *very little* to (2) *some* to (3) *quite a bit* to (4) *very much*. These measures were taken from Bloom's Taxonomy (Anderson, Krathwohl, & Bloom, 2001; Bloom, 1956), which classifies and ranks cognitive, affective, and psychomotor domains. My interest was in the cognitive domain. Memorization or knowledge is the lowest order thinking skill, moving up through comprehension, application, analysis, synthesis, and evaluation. The revised taxonomy (Anderson, et al., 2001) determined synthesis was actually the highest order thinking skill and used verbs instead of nouns to order the cognitive skills as remembering, understanding, applying, analyzing, evaluating, and creating. I combined the individual cognitive activities from NSSE items into one indicator called Bloom's Taxonomy scale.

Memorization. Remembering is the ability to retrieve knowledge (Anderson, et al., 2001). Memorization, however, also has the connotation of rote learning. The most

common answer students gave was *quite a bit* (3). The average score for institutions asking their students to memorize was 2.76 falling closer to *quite a bit* (3) than to *some* (2). The minimum was 1.53 and the maximum was 3.25, ranging from *very little* (1) to *quite a bit* (4).

Application. Applying is implementing knowledge or a procedure in a particular situation (Anderson, et al., 2001). The most common answer students gave was *quite a bit* (3). The average score for institutions asking their students to apply their learning fell near *quite a bit* (3) with a mean of 3.11. The minimum fell halfway between *some* (2) and *quite a bit* (3) at 2.57 and the maximum halfway between *quite a bit* (3) and *very much* (4) at 3.52.

Analysis. Analyzing is breaking ideas or texts into parts in order to see how they relate to each other and to the whole (Anderson, et al., 2001). The most common answer students gave was *quite a bit* (3). The average score for institutions asking their students to analyze as they learn fell near *quite a bit* (3) with a mean of 3.18. The minimum fell between *some* (2) and *quite a bit* (3) at 2.70 and the maximum approached *very much* (4) at 3.68.

Synthesis. Synthesizing or creating is making parts into a whole to generate a new pattern or structure (Anderson, et al., 2001). The most common answer students gave was *quite a bit* (3). The average score for institutions asking their students to synthesize as they learn was *quite a bit* (3) with a mean of 2.98. The minimum fell halfway between *some* (2) and *quite a bit* (3) at 2.46 and the maximum halfway between *quite a bit* (3) and *very much* (4) at 3.56.

Evaluation. Evaluating is making a judgment based on criteria and standards (Anderson, et al., 2001). The most common answer students gave was *quite a bit* (3). The average score for institutions asking their students to evaluate as they learn was *quite a bit* (3) with a mean of 2.93. The minimum fell between *some* (2) and *quite a bit* (3) at 2.52 and the maximum approached *quite a bit* (3) at 2.93.

Summary of Bloom's Taxonomy Indicators. Students claimed that they were frequently asked to utilize all five levels of critical thinking but on average, institutions asked students to apply and to analyze more than they asked them to synthesize and evaluate. Though memorization was requested less frequently on average, it was the indicator that had the most variation in responses.

Bloom's Taxonomy scale

Cronbach's Alpha reliability coefficient is a measure of the reliability of a scale that tests for internal consistency. As a rule of thumb, estimates of Cronbach's Alpha coefficient for a set of items or indicators should be at least .7 on a scale of 0 to 1.0 before those items are combined for use in a scale (George & Mallery, 2003). When combining the five cognitive indicators into a single scale, a reliability analysis revealed a completely unacceptable Cronbach's Alpha reliability coefficient of .451 (George & Mallery, 2003). However, a comparison of inter-item statistics revealed that removing the memorized indicator resulted in an excellent estimate of Cronbach's Alpha reliability coefficient of .923 (see Table 5) (George & Mallery, 2003). This made sense, as memorization is a lower order thinking skill that, though a prerequisite to learning, contributes less to learning than do the higher order thinking skills.

Table 5:
Bloom's Taxonomy: Item-Total Statistics (N = 497)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Memorized	12.21	.242	-.456	.923
Applied	11.86	.124	.694	.148
Analyzed	11.79	.108	.673	.072
Synthesized	11.99	.106	.562	.122
Evaluated	12.04	.119	.701	.120

As a result, I constructed a Bloom's Taxonomy scale by calculating the mean of the four remaining indicators of applied, analyzed, synthesized, and evaluated.

Critical Thinking

NSSE asked students to respond on the extent to which the institution contributed to their knowledge, skill, and personal development in thinking critically and analytically on the four-point scale of (1) *very little* (2) *some* (3) *quite a bit* (4) *very much*. The institutional average of students' responses was 3.30, which translated to just a bit more than *quite a bit*. The minimum was 2.81, which was nearly *quite a bit* and the maximum was 3.80, which approached *very much*. The most common answer was *very much* (4).

Lifelong Learning

NSSE asked to what extent the institution contributed to students' knowledge, skill, and personal development in learning effectively on their own on the four point scale of (1) *very little* (2) *some* (3) *quite a bit* (4) *very much*. The institutional average of students' responses was 2.96, which translated to *quite a bit*. The minimum was 2.58, which was halfway between *some* and *quite a bit* and the maximum was 3.60, which was midway between *quite a bit* and *very much*. The most common answer was *quite a bit* (3).

Grades

Students self-report their grades to NSSE on an eight point scale. The institutional average was a solid B+ with a minimum of B- and a maximum of A-. The median was A- (7) and the mode was A (8). In other words, it was most common for students to rate themselves as A students. I included grades as an observed measure because Cabrera, Nora, and Castañeda (1993, p. 128) included them. On the surface, grades seemed like they might be a good indicator for Academic Performance, but they proved to be challenging on many levels. First, grades are not necessarily valid representations of learning, but instead a reflection of a multitude of factors in the classroom. Second, the mean for an entire institution hides differentiation among students, which is problematic because the difficulty of grading across institutions does not necessarily measure levels of learning. Finally, the grades are self-reported. In their model, Cabrera, Nora, and Castañeda (1993) were able to use the actual GPA, as they were able to mine the student databases at their institution. The literature has shown students self-reported grades to be potentially unreliable, as students tend to inflate their scores. Kuncel, Credé, and Thomas (2005) conducted a literature review and meta-analysis on the accuracy of self-reported grades. They found that, while the literature varied greatly on the reliability of grades with estimated correlations from a low of .45 to a high of .98 (p. 67), their meta-analysis revealed that students with high ability and high GPAs reflected actual grades reasonably well, but that students with low ability and low GPAs did not accurately reflect actual grades (p. 74). As a result, they suggest caution when using self-reported grades (p. 78). Because NSSE offers other measures for academic performance, and taking into

consideration the recommendations made by Kuncel et al. (2005), I chose not use grades as an indicator for academic performance.

Summary of Academic Performance Indicators

Overall, students felt that the institution contributed very much to their higher order and critical thinking and quite a bit to their lifelong learning. Table 6 summarizes the revised Academic Performance construct.

Table 6:
Academic Performance Construct: Descriptive Statistics for Bloom's Taxonomy, Critical Thinking, Lifelong Learning, and Grades (N = 497)

	Mean	SD	Minimum	Maximum
Bloom's Taxonomy	3.05	.123	2.64	3.51
Critical thinking	3.30	.146	2.81	3.80
Lifelong learning	2.96	.135	2.59	3.61

Academic Integration Construct

The Academic Integration construct is indexed by observed measures for the extent of student academic engagement at an institution in terms of active and collaborative learning, course challenge, and course interaction. I obtained the Academic Integration indicators from the 2006 NSSE.

Pike's Scalelets

Pike (2006b) developed twelve, small, reliable scalelets that he determined better described student engagement than the larger indexes developed by NSSE. His goal was to provide more granular descriptions of student educational experiences so that institutions could target their assessment and improvement efforts (Pike, 2006a). Of the twelve, four applied to the Academic Integration construct (Active Learning, Collaborative Learning, Course Challenge, and Course Interaction) and one applied to the

Institutional Commitment construct (Support for Student Learning). I tested the reliability of each of Pike's scalelets before utilizing them.

Pike's Active Learning scalelet

Active learning measures how often students ask questions, make presentations, and are involved in service learning. Pike claimed that these three measures, taken from the NSSE Active and Collaborative Learning Index, provided a more granular and accurate view of student active learning.

Table 7:
Academic Integration Construct, Pike's Active Learning Scalelet: Descriptive Statistics for Asking Questions, Making Presentations, and Service Learning (N = 497)

	Mean	SD	Minimum	Maximum
Asked questions	3.04	.196	2.48	3.61
Made presentation	2.61	.221	1.98	3.43
Service learning	1.68	.233	1.08	2.80
Wrote a paper	3.23	.138	2.78	3.67

NSSE used a scale that went from (1) *never* to (2) *sometimes* to (3) *often* to (4) *very often* for the following questions.

Asked Questions. The institutional average of students' responses was that they *often* (3.04) asked questions in class or contributed to class discussions. The minimum was midway (2.48) between sometimes and *often* while the maximum was halfway between *often* and *very often* (3.61). The median was *quite a bit* (3) and the mode was *very often* (4).

Made Presentation. Students were not quite as likely to make presentations, reporting just slightly past the midpoint between *sometimes* and *often* (2.61). The minimum and maximum were also lower, at *sometimes* (1.98) and halfway between *often* and *very often* (3.43). The mode was *sometimes* (2).

Service Learning. Students were far less likely to have participated in a community-based project as part of a regular course. The most common answer was *never* (1), and the average was well below *sometimes* (1.68). The minimum was virtually *never* (1.08) while the maximum approached *often* (2.80).

Integrated Ideas. Students reported that they often (3.23) worked on a paper or project that required integrating ideas or information from various sources. The minimum approached *often* (2.78) while the maximum was halfway between *often* and *very often* (3.67). The median and the mode were both *quite a bit* (3). Note that integrated ideas is not an indicator in Pike's Active Learning scalelet, but I included it here because face validity suggests that it is a reasonable indicator for active learning.

Summary of Active Learning Indicators. Students often asked questions and made presentations, but rarely if ever participated in service learning activities. They also often wrote papers or worked on projects that required them to integrate ideas or information from various sources.

Reliability of Pike's Active Learning scalelet

A reliability analysis of Pike's three active learning indicators reveals a questionable estimate of Cronbach's Alpha reliability coefficient of .607 (George & Mallery, 2003). However, the addition of *integrated ideas* to the scalelet produces an acceptable estimate of Cronbach's Alpha reliability coefficient of .717. A further comparison of inter-item statistics reveals that removing the *service learning* indicator, which was rarely if ever used in the sample, results in a good (George & Mallery, 2003) estimate of Cronbach's Alpha reliability coefficient of .793 (see Table 8).

Table 8:
Pike's Active Learning Scalelet: Item-Total Statistics (N = 497)

Pike's Active Learning Scalelet: Item-Total Statistics (N = 497)	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Asked questions	7.52	.200	.614	.588
Made presentation	7.95	.190	.558	.622
Service Learning	8.88	.225	.305	.793
Integrated Ideas	7.34	.237	.672	.607

As a result, I modified Pike's Active Learning scalelet by calculating the mean of three items: his two original indicators of *asked questions* and *made presentation* with the addition of *integrated ideas*.

Pike's Collaborative Learning scalelet

Collaborative learning is indexed by how often students interact with their classmates as they learn. Pike took the questions regarding participation in group projects in and out of class, discussing ideas with students, and tutoring other students from the NSSE Active and Collaborative Learning index and created a scalelet for collaborative learning. See Table 9 for descriptive statistics for each question.

Table 9:
Academic Integration Construct, Pike's Collaborative Learning Scalelet: Descriptive Statistics for Group Projects In and Out Of Class, Tutoring, and Discussing Ideas with Students (N = 497)

	Mean	SD	Minimum	Maximum
Group project in class	2.46	.171	1.82	2.95
Group project outside class	2.59	.202	2.06	3.47
Discussed ideas with students	2.81	.164	2.38	3.55
Tutored	1.82	.154	1.40	2.41

Group Project in Class. Students worked with other students on projects during class halfway between *sometimes* and *often* (2.46). The minimum (1.82) approached *sometimes* and the maximum (2.95) was *often*. The mode was *sometimes* (2).

Group Project outside Class. Students worked with classmates outside of class to prepare class assignments slightly more often, once again reporting numbers halfway between *sometimes* and *often* (2.59). The minimum (2.06) was *sometimes* and the maximum (3.47) was halfway between *often* and *very often*. The mode was *sometimes* (2).

Discussed ideas with students. Students discussed ideas from their readings or classes with others outside of class such as students, family, and co-workers fairly *often* (2.81). The minimum (2.38) reflects that students *sometime* discuss while the maximum approaches *often*. The mode was *often* (3).

Tutored. Students were nowhere near as likely to tutor other students, reporting a number less than sometimes (1.82). The minimum (1.40) was closer to *never* than to *sometimes* while the maximum (2.41) was closer to *sometimes* than *often*. The median and the mode were both *never* (2).

Summary of Collaborative Learning indicators. Students often discuss ideas with their classmates and worked on projects in and out of class, but only sometimes tutored other students.

Reliability of Pike's Collaborative Learning scalelet

A reliability analysis of Pike's four collaborative learning indicators revealed a completely unacceptable estimate of Cronbach's Alpha reliability coefficient of .348 (George & Mallery, 2003). In fact, there is negative average covariance among variables, which violates reliability model assumptions. Removing group project in class results in a questionable (George & Mallery, 2003) estimate of Cronbach's Alpha reliability coefficient of .603 (see Table 10).

Table 10:
Pike's Collaborative Learning Scalelet: Item-Total Statistics (N = 497)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Group project in class	7.22	.153	-.141	.603
Group project outside class	7.09	.071	.477	-.186[a]
Tutored	7.86	.093	.494	-.062[a]
Discussed ideas with students	6.86	.130	.052	.419

a. The value is negative due to a negative average covariance among items. This violates reliability model assumptions.

A comparison of inter item statistics reveals that removing the *discussed ideas with students* indicator results in an acceptable estimate of Cronbach's Alpha reliability coefficient of .762.

Table 11:
Pike's Collaborative Learning Scalelet: Item-Total Statistics (N = 497)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Group project outside class	4.63	.064	.475	.409
Tutored	5.40	.076	.620	.226
Discussed ideas with students	4.40	.104	.204	.762

As a result, I modified Pike's Collaborative Learning scalelet by calculating the mean of the two remaining indicators of *group project outside of class* and *tutored*. It is critical to note that though the scale is reliable per the estimate of Cronbach's Alpha reliability coefficient, removing two variables means that the scalelet might be suspect in that group projects and tutoring may not in of themselves reflect collaborative learning.

Pike's Course Challenge scalelet

Course Challenge measures on average how challenging students found their coursework.

Table 12:
Academic Integration Construct, Pike's Course Challenge Scalelet: Descriptive Statistics for Unprepared Students, Working Hard, Challenging Exams, Hours Studying, and Institutional Emphasis on Studying (N = 497)

	Mean	SD	Minimum	Maximum
Came unprepared	2.01	.121	1.53	2.36
Worked hard	2.70	.139	2.27	3.25
Exams challenged	5.46	.197	4.63	6.12
Hours studying	4.15	.474	3.13	6.72
Institutional emphasis on studying	3.13	.183	2.55	3.81

Came Unprepared. On average, students *sometimes* (2.01) came to class without completing readings or assignments. The minimum (1.53) fell halfway between *never* and *sometimes* while the maximum (2.36) fell just over *sometimes*. The mode was *sometimes* (2).

Worked Hard. On average, students worked harder than they thought they could to meet an instructor's standards or expectations fairly *often* (2.70). The minimum (2.27) indicated that students on that campus *sometimes* worked hard while at the campus represented by the maximum (3.25) number *often* worked hard. The mode was *often* (3).

Exams Challenged. On a seven point Likert scale (with 1 = very little and 7 = very much), students found that exams challenged them to do their best work an average of 5.46. The minimum was 4.36 and the maximum 6.12. The median and the mode were both 6.

Hours Studying. On average, students claimed to study between 11-20 hours in a typical 7-day week. At minimum, students studied between 6-10 hours and at maximum

they studied between 21-30 hours per week. The median and the mode were both *6-10 hours* (3).

Institutional Emphasis on Studying. On average, students reported that their institution *often* (3.13) emphasized spending significant amounts of time studying and on academic work. At minimum (2.55), students reported halfway between *sometimes* and *often*. At maximum (3.81), students reported close to very often. The mode was *often* (3).

Summary of Course Challenge indicators. Though students sometimes came to class unprepared, they often worked harder than they thought they could and spent many hours studying, at times perhaps due to challenging exams.

Reliability of Pike's Course Challenge scalelet

A reliability analysis of Pike's five collaborative learning indicators revealed a completely unacceptable estimate Cronbach's Alpha reliability coefficient of .541 (George & Mallery, 2003). This is likely because coming unprepared to class runs counter to the idea that a course is challenging. This was confirmed by a comparison of inter item statistics that revealed removing the *came unprepared* indicator results in a higher, but questionable, estimate of Cronbach's Alpha reliability coefficient of .623 (see Table 13).

Table 13:
Pike's Course Challenge Scalelet: Item-Total Statistics (N = 497)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Came unprepared	15.44	.594	-.135	.623
Worked hard	14.75	.522	.209	.538
Exams challenged	12.00	.427	.456	.422
Hours studying	13.30	.166	.500	.480
Institutional emphasis on studying	14.32	.372	.799	.267

A further comparison of inter item statistics revealed removing the *hours studying* indicator resulted in an acceptable Cronbach's Alpha reliability coefficient of .745. Hours studying could be as much a reflection on a student's ability as the level of course challenge, so this makes sense as well. As a result, I modified Pike's Course Challenge scalelet by calculating the mean of the three remaining indicators of *worked hard*, *exams challenged*, and *institutional emphasis on studying*.

Pike's Course Interaction scalelet

Course Interaction measures on average how students interact with faculty (see Table 14).

Table 14:
Academic Integration Construct, Pike's Course Interaction Scalelet: Descriptive Statistics for Discussing Grades, Discussing Ideas, and Feedback (N = 497)

	Mean	SD	Minimum	Maximum
Discussed grades	2.75	.142	2.37	3.31
Discussed ideas with faculty	2.04	.180	1.68	3.01
Received feedback	2.77	.159	2.26	3.39

Discussed Grades. On average, students discussed grades or assignments with an instructor fairly *often*. At minimum (2.37), students *sometimes* discussed grades. At maximum (3.31), students *often* discussed grades. The mode was *sometimes* (2).

Discussed Ideas with Faculty. On average, students *sometimes* (2.04) discussed ideas from their readings or classes with faculty members outside of class. At minimum (1.68), students discussed ideas between *never* and *sometimes*. At maximum (3.01), students *often* discussed ideas. The mode was *sometimes* (2).

Received Feedback. On average, students received prompt written or oral feedback from faculty on their academic performance fairly *often* (2.77). At minimum

(2.26), they *sometimes* received prompt feedback. At maximum (3.39), they *often* received prompt feedback. The mode was *often* (3).

Summary of Course Interaction indicators. Students often discussed grades and received feedback from faculty, but only sometimes discussed ideas with them outside of class.

Reliability of Pike's Course Interaction scalelet

A reliability analysis of Pike's three collaborative learning indicators revealed a good (George & Mallery, 2003) estimate of Cronbach's Alpha reliability coefficient of .873 (see Table 15).

Table 15:
Pike's Course Interaction Scalelet: Item-Total Statistics (N = 497)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Discussed grades	4.81	.098	.771	.819
Discussed ideas with faculty	5.52	.076	.790	.798
Received feedback	4.79	.091	.732	.842

As a result, I calculated Pike's Course Interaction scalelet as the mean of the three indicators of *discussed grades, discussed ideas with faculty*, and *received prompt feedback*.

Academic Integration Construct Revisited

I retained all four of Pike's scalelets to index the Academic Integration Construct as I had originally theorized, though I modified his Active Learning and Collaborative Learning indicators based on an analysis of scale reliability (see Table 16).

Table 16:
Academic Integration Construct: Descriptive Statistics for Pike's Scalelets for Active Learning, Collaborative Learning, Course Challenge, and Course Interaction (N= 497)

	Mean	SD	Minimum	Maximum
Pike's Active Learning scalelet	2.83	.182	2.34	3.38
Pike's Collaborative Learning scalelet	2.20	.162	1.80	2.92
Pike's Course Challenge scalelet	3.76	.142	3.24	4.30
Pike's Course Interaction scalelet	2.52	.144	2.19	3.20

Institutional Commitment Construct

Institutional commitment is an abstract construct that is measured by the relationships between students and other students, faculty, and administrators and student services, along with the extent to which the institution supports student success (see Table 17). I obtained the Institutional Commitment data from the 2006 NSSE.

Table 17:
Institutional Commitment Construct: Descriptive Statistics for Relationships with Other Students, Faculty, and Administrators (N = 497)

	Mean	SD	Minimum	Maximum
Student relationships	5.64	.223	4.64	6.26
Faculty relationships	5.53	.281	4.75	6.40
Administrative relationships	4.72	.353	3.66	5.82
Institutional academic support	3.04	.185	2.55	3.70
Institutional work and family support	2.11	.191	1.65	2.83
Institutional social support	2.32	.194	1.79	3.13

Student Relationships. Students rated their relationships with other students on a scale of 1 (Unfriendly, Unsupportive, Sense of Alienation) to 7 (Friendly, Supportive, Sense of Belonging). On average, students ranked the quality of their relationships with other students at their institution close to six (5.64) on a seven point Likert scale, rating them as being friendly and supportive and providing a sense of belonging. At the low end, institutions were still ranked above the middle (4.64) while the high end was slightly more positive than the mean (6.26). The median was 6 and the mode was 7.

Faculty Relationships. Students rated their relationships with faculty on a scale of 1 (Unavailable, Unhelpful, Unsympathetic) to 7 (Available, Helpful, Sympathetic). On average, students ranked the quality of their relationships with faculty members at their institution close to six (5.53) on a seven point Likert scale, rating them as being available and helpful and sympathetic. At the low end, institutions were still ranked above the middle (4.75) while the high end was slightly more positive than the mean (6.40). The median and the mode were both 6.

Administrative Relationships. Students rated their relationships with administrative personnel and offices on a scale of 1 (Unhelpful, Inconsiderate, Rigid) to 7 (Helpful, Considerate, Flexible). Administrators and students services did not fare as well as did other students and faculty. On average, students ranked the quality of their relationships with administrative personnel and student services at their institution close to the middle (4.72) on a seven point Likert scale, rating them as being halfway between unhelpful, inconsiderate, and rigid and helpful, considerate, and flexible. The median and the mode were both 5.

Support for Student Success

Support for student success is measured by the amount of academic, work and family, and social support the institution offers. See Table 18.

Table 18:
Academic Integration Construct, Pike's Support for Student Success Scalelet: Descriptive Statistics for Institutional Academic, Work and Family, and Social Support (N = 497)

	Mean	SD	Minimum	Maximum
Institutional academic support	3.04	.185	2.55	3.70
Institutional work and family support	2.11	.191	1.65	2.83
Institutional social support	2.32	.194	1.79	3.13

Institutional Academic Support. On average, students reported that their institutions provide *quite a bit* (3.04) of the support they need to help them succeed academically. At a minimum (2.55), institutions provided somewhere between *some* and *quite a bit*. At a maximum (3.70), institutions provided close to *very much*. The mode was *often* (3).

Institutional Work and Family Support. On average, students reported that their institutions provide *some* (2.11) of the help they needed to cope with non-academic responsibilities such as work and family. At minimum (1.65), institutions provided between *very little* and *some* help. At maximum (2.83), institutions approached providing *quite a bit* of help. The mode was *sometimes* (2).

Institutional Social Support. On average, students felt that institutions provide *some* (2.32) support they need to thrive socially. At minimum (1.79), social support approached *some*. At maximum (3.13), social support exceeded *quite a bit*. The mode was *sometimes* (2).

Summary of Institutional Support indicators. Students had high quality relationships with their classmates and with faculty, but only middling relationships with administrators and student support offices. This matched well with their sense that their institutions supported them quite a bit academically, but only somewhat supported their work, family, and social lives.

Reliability of Pike's Support for Student Success scalelet

A reliability analysis of Pike's three *support for student success* indicators revealed an excellent estimate of Cronbach's Alpha reliability coefficient of .898 (George & Mallery, 2003) (George & Mallery, 2003). As a result, I calculated Pike's Support for

Student Success scalelet as the mean of the three indicators of *institutional academic support*, *institutional work and family support*, and *institutional social support*.

Institutional Commitment Construct Revisited

The Institutional Commitment construct was indexed by student relationships with other students, faculty, and administrators, and Pike's Support for Student Success scalelet (see Table 19).

Table 19:
Institutional Support Construct: Descriptive Statistics for Student Relationships, Faculty Relationships, Administrative Relationships, and Pike's Support for Student Success Scalelet (N = 497)

	Mean	SD	Minimum	Maximum
Student relationships	5.64	.223	4.64	6.26
Faculty relationships	5.53	.281	4.75	6.40
Administrative relationships	4.72	.353	3.66	5.82
Pike's Support for Student Success scalelet	2.489	.173	2.00	3.11

Intent to Persist Construct

Intent to persist measures the commitment students have to returning to school and completing their education. Intent was indicated by students' overall educational experience and whether or not they would return to the same institution if they could start over. I obtained the Intent to Persist from the 2006 NSSE Survey. See Table 20.

Table 20:
Intent to Persist Construct: Descriptive Statistics for Overall Experience and Return to Institution (N = 497)

	Mean	SD	Minimum	Maximum
Return to institution	3.19	.173	2.46	3.72
Overall experience	3.23	.174	2.76	3.72

Return to Institution. Students would *probably* return to the same institution they were attending if they could start over again (3.19). On the low end, students were split

between *probably no* and *probably yes* (2.46) while at the high end, students leaned toward *definitely yes* (3.72). The mode was *probably yes* (3).

Overall Experience. Students rated their overall experience at the institution as *good* (3.23). At the low end, ratings approached *good* (2.76) and at the high end they approached *excellent* (3.72). The mode was *good* (3).

Summary of Intent to Persist indicators. Students rated their overall experience as good and would probably return to the same institution if they could do it all over.

Persistence Construct

Retention and graduation are measures of student persistence. Retention measures the percentage of full time students who return to school at the beginning of their sophomore year. Retention rates were included for 2006 and for 2007; 2006 provided a cross section while 2007 provided an actual percentage of students who returned. Note however, that the numbers were not broken down by year in college, so it was impossible to claim a direct relationship between variables.

Graduation measures the number of students who earn a degree with six years of matriculating. Graduation rates were included for 2006 and 2007, which was a cross section rather than a longitudinal measure in that it did not reflect actual graduation rates (which for freshmen in this sample would have been in 2012). I extracted the Persistence indicators from the 2006 and 2007 IPEDS Integrated Postsecondary Education Data System. See Table 21.

Table 21:
Persistence Construct: Descriptive Statistics for Retention and Graduation Rates in 2006 and 2007 (N = 497)

	Mean	SD	Minimum	Maximum
Retention 2006	74.98	10.698	34	98
Retention 2007	74.92	10.849	41	97
Graduation 2006	54.71	16.914	15	93
Graduation 2007	55.07	16.979	13	93

Retention. Retention rates for 2006 and 2007 varied greatly. In 2006, there was a minimum of 34% and a maximum of 98% for a range of 64 and a standard deviation of 10.7. In 2007, there was a minimum of 41% and a maximum of 97% for a range of 56 and a standard deviation of 10.8. All of these numbers showed very large variation across institutions.

Graduation. Graduation rates for 2006 and 2007 varied even more greatly than retention numbers. In 2006, there was a minimum of 15% and a maximum of 93% for a range of 78 and a standard deviation of 16.9. In 2007, there was a there was a minimum of 13% and a maximum of 93% for a range of 80 and a standard deviation of 17.0. All of these numbers showed very large variation across institutions.

Correlation Analysis

Structural Equation Modeling compares the observed correlation matrix from the sample against a population covariance matrix estimated from the model to see if they are consistent (Byrne, 2010, pp. 6-8). This is why structural equation modeling is also called analysis of covariance. In other words, structural equation modeling measures how well the entire model of observed (measured indicators) and unobserved variables (latent constructs) work together. The estimated correlation matrix for the observed indicators in the model can be found in Table 21.

For the purposes of this model, correlations are defined as follows:

- weak < .3
- moderate .3 to .7
- strong > .7

Variables that index the same construct should correlate with each other. However, correlations greater than .85 are considered collinear and may make certain mathematical operations unstable as some denominators approach zero (Kline, 2005, p. 56). Retention 2006 and Retention 2007 (.895) and Graduation 2006 and Graduation 2007 (.902) were both collinear. I therefore used only the 2006 measures for each. More problematic was the collinearity between Experience and Return (.854). Experience and Return were the only two observed measures for the Intent to Persist construct. Since structural equation modeling suggests a minimum of two observed variables for each latent variable, I kept both experience and return as indicators for Intent to Persist. I also calculated a new indicator named satisfaction as the mean of the two indicators for use when collinearity might have caused measurement errors.

SPSS AMOS uses the estimated correlation matrix to test for model fit. The correlations between observed measures determine the variance of the latent variables and between latent variables. It is the difference in the variance between the predicted model and the observed model that determines whether or not a model fits. I used SPSS to construct the estimated correlation matrix See Table 22 for the complete estimated correlation matrix.

Table 22:
Estimated Correlation Matrix with Library Log 10 Variables (N = 497)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Librarians	1																				
2. Expenditures	-.112*	1																			
3. Circulation	-.131**	.843**	1																		
4. Instruction	-.276**	.828**	.718**	1																	
5. Bloom's.	.323**	-.055	-.050	-.222**	1																
6. Critical	.365**	-.104*	-.061	-.294**	.825**	1															
7. Lifelong	.302**	-.136**	-.098*	-.283**	.682**	.749**	1														
8. Active	.171**	-.446**	-.409**	-.408**	.614**	.442**	.449**	1													
9. Collaborative	.176**	.022	-.039	-.093*	.345**	.391**	.255**	.062	1												
10. Challenge	.274**	-.146**	-.178**	-.228**	.589**	.674**	.596**	.347**	.295**	1											
11. Interaction	.405**	-.400**	-.358**	-.488**	.684**	.617**	.630**	.673**	.313**	.454**	1										
12. Students	.101*	-.336**	-.289**	-.300**	.173**	.322**	.371**	.235**	.337**	.399**	.266**	1									
13. Faculty	.367**	-.604**	-.471**	-.612**	.494**	.576**	.513**	.550**	.195**	.403**	.742**	.548**	1								
14. Administration	.117**	-.548**	-.468**	-.471**	.212**	.357**	.375**	.353**	.115*	.374**	.397**	.605**	.690**	1							
15. Support	.306**	-.376**	-.320**	-.400**	.367**	.506**	.502**	.268**	.392**	.390**	.529**	.642**	.728**	.642**	1						
16. Experience	.330**	-.115*	.015	-.241**	.580**	.751**	.596**	.244**	.367**	.543**	.481**	.506**	.686**	.525**	.685**	1					
17. Return	.145**	-.015	.141**	-.099*	.352**	.547**	.507**	.098*	.232**	.347**	.253**	.499**	.499**	.496**	.542**	.854**	1				
18. Retention 2006	.179**	.409**	.409**	.251**	.378**	.352**	.181**	-.109*	.307**	.189**	.025	.034	.012	-.132**	.170**	.471**	.357**	1			
19. Retention 2007	.157**	.404**	.407**	.229**	.365**	.331**	.144**	-.150**	.329**	.201**	-.003	.076	.006	-.096*	.158**	.477**	.360**	.895**	1		
20. Graduation 2006	.294**	.208**	.245**	.042	.434**	.426**	.229**	.024	.383**	.225**	.178**	.152**	.209**	-.024	.304**	.557**	.367**	.821**	.799**	1	
21. Graduation 2007	.292**	.194**	.244**	.062	.401**	.388**	.214**	-.006	.347**	.230**	.147**	.172**	.221**	.037	.317**	.578**	.403**	.812**	.785**	.902**	1

** Correlation is significant at the 0.01 level.

Correlation Matrices Comparing Indicators from Each Construct

In this section, I broke down the large estimated correlation matrix into sub-sections for a closer analysis. For the Library construct indicators, I also compared my originally hypothesized indicators with ratios of those same indicators.

Library Construct Indicators and Academic Performance Construct Indicators

The Library construct indicators showed few statistically significant relationships with Academic Performance. The ratio of librarians to students showed a statistically significant moderate positive relationship with Bloom's Taxonomy ($r = .323$, $p < .001$), critical thinking ($r = .365$, $p < .001$), and lifelong learning ($r = .392$, $p < .001$). However, expenditures, circulation, and instruction actually showed weak negative relationships with each indicator of academic performance if they showed any relationship at all (see Table 23). Overall, with the exception of the librarians indicator, library indicators showed weak negative relationships with academic performance indicators. This relationship ran counter to the literature showing that the library correlates positively with academic performance, suggesting that other factors were at play. Specifically, I believe that the size of the institution may have had an impact on the correlation.

Table 23:
Estimated Correlation Matrix Showing Relationships between Library Construct Indicators and Academic Performance Indicators (N = 497)

	Librarians	Expenditures	Circulation	Instruction	Bloom's	Critical	Lifelong
Librarians	1						
Expenditures	-.112*	1					
Circulation	-.131**	.843**	1				
Instruction	-.276**	.828**	.718**	1			
Bloom's	.323**	-.055	-.050	-.222**	1		
Critical	.365**	-.104*	-.061	-.294**	.825**	1	
Lifelong	.302**	-.136**	-.098*	-.283**	.682**	.749**	1

I therefore adjusted for the variation in the size of each library by converting all measures into ratios. As a result, a different picture emerged in the estimated correlation matrix (see Table 24). The alternate ratio of expenditures to students now showed a weak, positive statistically significant relationship with all Academic Performance indicators. The ratios of circulation and instruction to students now both showed a statistically significant but weak positive relationship with Bloom's Taxonomy and critical thinking. This suggested that controlling for institutional size painted a picture more aligned with the literature.

Table 24:
Estimated Correlation Matrix showing Relationships between Library Ratio Construct Indicators and Academic Performance Indicators (N=497)

	Librarians	Expenditures	Circulation	Instruction	Bloom's	Critical	Lifelong
Librarians	1						
Expenditures	.308**	1					
Circulation	.148**	.573**	1				
Instruction	.062	.312**	.221**	1			
Bloom's	.323**	.175**	.110*	.106*	1		
Critical	.365**	.223**	.102*	.123**	.825**	1	
Lifelong	.302**	.101*	-.003	.039	.682**	.749**	1

Library Construct Indicators and Academic Integration Construct Indicators

The Library construct indicators and Academic Integration construct indicators had mostly weak, negative statistically significant relationships with the exception of a positive weak relationship with ratio of librarians to students. Library expenditures, circulation, and instruction all showed statistically significant weak to moderate negative relationships with active learning, course challenge, and course interaction (see Table 25). Though the literature is weaker in linking the library to academic integration, the relationship has been demonstrated in a sufficient number of studies to indicate that institutional size may continue to be a confounding factor in my sample.

Table 25:
Estimated Correlation Matrix Showing Relationship between Library Construct Indicators and Academic Integration Indicators (N = 497)

	Librarians	Expenditures	Circulation	Instruction	Active	Collaborative	Challenge	Interaction
Librarians	1							
Expenditures	-.112*	1						
Circulation	-.131**	.843**	1					
Instruction	-.276**	.828**	.718**	1				
Active	.171**	-.446**	-.409**	-.408**	1			
Collaborative	.176**	.022	-.039	-.093*	.062	1		
Challenge	.274**	-.146**	-.178**	-.228**	.347**	.295**	1	
Interaction	.405**	-.400**	-.358**	-.488**	.673**	.313**	.454**	1

Adjusting for library size by transforming library variables to ratios changed the relationships (see Table 26). The ratios of expenditures per student and of instruction per student now showed statistically significant positive relationships with course challenge and with collaborative learning, while the ratio of circulation to student showed a statistically significant positive relationship only with course challenge. However, the relationship between library expenditures, circulation, and instruction per student

remained negative for active learning. While I do believe that the academic library promotes active learning, I also understand that the observed measures that I used as library indicators did not necessarily measure which libraries engaged their students better.

Table 26:
Estimated Correlation Matrix Showing Relationships between Library Ratio Construct Indicators and Academic Integration Indicators (N = 497)

	Librarians	Expenditures	Circulation	Instruction	Active	Collaborative	Challenge	Interaction
Librarians	1							
Expenditures	.308**	1						
Circulation	.148**	.573**	1					
Instruction	.062	.312**	.221**	1				
Active	.171**	-.159**	-.105*	-.050	1			
Collaborative	.176**	.205**	.085	.185**	.062	1		
Challenge	.274**	.092*	.003	.059	.347**	.295**	1	
Interaction	.405**	.066	.024	.038	.673**	.313**	.454**	1

Library Construct Indicators and Institutional Commitment Construct Indicators

The Library construct indicators and Institutional Commitment construct indicators had mostly weak to moderate negative relationships with the exception of a positive weak relationship with ratio of librarians to students. Library expenditures, circulation, and instruction all showed statistically significant weak to moderate negative relationships with relationship with other students, with faculty, and with administrators (see Table 27). The literature connecting the library to institutional commitment is sparse, but since size has been an issue for every library indicator, I once again adjusted for institutional size.

Table 27:
Estimated Correlation Matrix Showing Relationships between Library Construct Indicators and Institutional Commitment Indicators (N = 497)

	Librarians	Expenditures	Circulation	Instruction	Students	Faculty	Administration	Support
Librarians	1							
Expenditures	-.112*	1						
Circulation	-.131**	.843**	1					
Instruction	-.276**	.828**	.718**	1				
Students	.101*	-.336**	-.289**	-.300**	1			
Faculty	.367**	-.604**	-.471**	-.612**	.548**	1		
Administration	.117**	-.548**	-.468**	-.471**	.605**	.690**	1	
Support	.306**	-.376**	-.320**	-.400**	.642**	.728**	.642**	1

When library indicators were converted to ratios to control for institution size, the relationship was statistically significant only for students' relationships with administrative offices on campus, showing a very weak negative relationship (see Table 28). If students associated the library with administration, then it makes sense that there was a statistically significant relationship with Institutional Commitment indicators. However, it makes less sense to me that the relationship was negative, perhaps because at my own university, the library is consistently rated the most service oriented office on campus. It is possible that I am wrong, that the same is not true on other campuses, but it is also possible that the overall negative correlation is due to the feelings students have about the bureaucracy on their campuses.

Table 28:
Estimated Correlation Matrix Showing Relationships between Library Ratio Construct Indicators and Institutional Support Indicators (N = 497)

	Librarians	Expenditures	Circulation	Instruction	Students	Faculty	Administration	Support
Librarians	1							
Expenditures	.308**	1						
Circulation	.148**	.573**	1					
Instruction	.062	.312**	.221**	1				
Students	.101*	-.042	-.086	-.014	1			
Faculty	.367**	-.008	-.034	-.021	.548**	1		
Administration	.117**	-.147**	-.138**	-.046	.605**	.690**	1	
Support	.306**	.057	.040	.005	.642**	.728**	.642**	1

Library Construct Indicators and Intent to Persist Construct Indicators

The Library construct indicators and Intent to Persist construct indicators had mostly weak to moderate negative relationships. The ratio of librarians to students had a positive weak relationship with intent to return ($r = .145$, $p < .001$) and a moderate positive relationship with overall experience ($r = .330$, $p < .001$). But, library expenditures, circulation, and instruction showed weak negative relationships if they showed any at all (see Table 29).

Table 29:
Estimated Correlation Matrix Showing Relationship between Library Construct Indicators and Intent to Persist Indicators (N = 497)

	Librarians	Expenditures	Circulation	Instruction	Experience	Return
Librarians	1					
Expenditures	-.112*	1				
Circulation	-.131**	.843**	1			
Instruction	-.276**	.828**	.718**	1		
Experience	.330**	-.115*	.015	-.241**	1	
Return	.145**	-.015	.141**	-.099*	.854**	1

When library indicators were converted to ratios to control for institution size, however, the relationship was statistically significant only for experience. Only the

librarians and expenditures showed statistically significant relationships with the return indicator (see Table 30). In addition, expenditures had a weak positive relationship with intent to return. This suggested that the library was correlated with students' overall experiences, but that the library had no relation with students' avowal that they would return to the same institution if they could do it all over again.

Table 30:
Estimated Correlation Matrix Showing Relationships between Library Ratio Construct Indicators and Intent to Persist Indicators (N = 497)

	Librarians	Expenditures	Circulation	Instruction	Experience	Return
Librarians	1					
Expenditures	.308**	1				
Circulation	.148**	.573**	1			
Instruction	.062	.312**	.221**	1		
Experience	.330**	.209**	.100*	.104*	1	
Return	.145**	.114*	.049	.055	.854**	1

Library Construct Indicators and Intent to Persist Construct Indicators

All library indicators showed a statistically significant weak to moderate positive relationship with the indicators for Persistence (retention and graduation) with the exception of instruction that showed no statistically significant relationship with graduation (see Table 31). I selected these indicators specifically because the literature showed that statistically significant relationships existed between the academic library and persistence (Emmons & Wilkinson, 2011; Hamrick, et al., 2004; Kramer & Kramer, 1968; Mallinckrodt & Sedlacek, 2009; Mezick, 2007). These figures for the most part affirmed the literature.

Table 31:
Estimated Correlation Matrix Showing Relationship between Library Construct Indicators and Persistence Indicators (N = 497)

	Librarians	Expenditures	Circulation	Instruction	Retention	Graduation
Librarians	1					
Expenditures	-.112*	1				
Circulation	-.131**	.843**	1			
Instruction	-.276**	.828**	.718**	1		
Retention	.179**	.409**	.409**	.251**	1	
Graduation	.294**	.208**	.245**	.042	.821**	1

When library indicators were converted to ratios to control for institution size, the relationships remained weak to moderate and positive, and instruction now also had a weak positive relationship with graduation ($r = .189$, $p < .001$), suggesting that increased student participation in library instruction was associated with higher graduation rates (and vice versa) and that lower levels of participation in library instruction was associated with lower graduation rates (see Table 32).

Table 32:
Estimated Correlation Matrix Showing Relationship between Library Ratio Construct Indicators and Persistence Indicators (N = 497)

	Librarians	Expenditures	Circulation	Instruction	Retention	Graduation
Librarians	1					
Expenditures	.308**	1				
Circulation	.148**	.573**	1			
Instruction	.062	.312**	.221**	1		
Retention	.179**	.362**	.240**	.158**	1	
Graduation	.294**	.350**	.233**	.189**	.821**	1

Complete Matrix with Library Ratio Indicators

I have compared two sets of library indicators. The first set included the ratio of librarians to students along with totals of expenditures, circulation of materials, and instruction of students. The second set converted total expenditures, circulation of materials, and instruction of students to ratios in order to control for the size of the

institution. A comparison of each showed that in most cases, when the measures were not converted to ratios, the estimated correlation coefficients suggested negative relationships; but when the measures were converted to ratios, the estimated correlation coefficients tended to be positive. I believe that this rings true, as absolute size of a library budget, total number of items circulated, and total number of classes taught by librarians make no sense outside the context of the size of the institution and the number of students served. In other words, large institutions tended to have more resources. And unless those resources were adjusted by the number of students they served, the statistics related to overall size instead of relative allocation and use of those resources.

Controlling for the size of the institution that hosted the library, therefore, made a difference in how the indicators referenced the construct. See Table 33 for a complete estimated correlation matrix in one table that presents the alternate library ratio indicators instead of the original library indicators.

Table 33:
Estimated Correlation Matrix with Library Ratios (Log 10) Variables (N = 497)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Librarians	1																		
2. Expenditures	.308**	1																	
3. Circulation	.148**	.573**	1																
4. Instruction	.062	.312**	.221**	1															
5. Bloom's.	.323**	.175**	.110*	.106*	1														
6. Critical	.365**	.223**	.102*	.123**	.825**	1													
7. Lifelong	.302**	.101*	-.003	.039	.682**	.749**	1												
8. Active	.171**	-.159**	-.105*	-.050	.614**	.442**	.449**	1											
9. Collaborative	.176**	.205**	.085	.185**	.345**	.391**	.255**	.062	1										
10. Challenge	.274**	.092*	.003	.059	.589**	.674**	.596**	.347**	.295**	1									
11. Interaction	.405**	.066	.024	.038	.684**	.617**	.630**	.673**	.313**	.454**	1								
12. Students	.101*	-.042	-.086	-.014	.173**	.322**	.371**	.235**	.337**	.399**	.266**	1							
13. Faculty	.367**	-.008	-.034	-.021	.494**	.576**	.513**	.550**	.195**	.403**	.742**	.548**	1						
14. Administration	.117**	-.147**	-.138**	-.046	.212**	.357**	.375**	.353**	.115*	.374**	.397**	.605**	.690**	1					
15. Support	.306**	.057	.040	.005	.367**	.506**	.502**	.268**	.392**	.390**	.529**	.642**	.728**	.642**	1				
16. Experience	.330**	.209**	.100*	.104*	.580**	.751**	.596**	.244**	.367**	.543**	.481**	.506**	.686**	.525**	.685**	1			
17. Return	.145**	.114*	.049	.055	.352**	.547**	.507**	.098*	.232**	.347**	.253**	.499**	.499**	.496**	.542**	.854**	1		
18. Retention	.179**	.362**	.240**	.158**	.378**	.352**	.181**	-.109*	.307**	.189**	.025	.034	.012	-.132**	.170**	.471**	.357**	1	
19. Graduation	.294**	.350**	.233**	.189**	.434**	.426**	.229**	.024	.383**	.225**	.178**	.152**	.209**	-.024	.304**	.557**	.367**	.821**	1

Academic Performance indicators with Persistence indicators

All indicators for Academic Performance showed statistically significant weak to moderate positive relationships with Persistence indicators (see Table 34). The relationship was moderate for Bloom's Taxonomy and Critical Thinking and weak for Lifelong Learning, confirming the common sense idea that there is a relationship between academic performance and retention and graduation.

Table 34:
Estimated Correlation Matrix showing Relationships between Academic Performance Indicators and Persistence Indicators (N = 497)

	Bloom's	Critical	Lifelong	Retention	Graduation
Bloom's	1				
Critical	.825**	1			
Lifelong	.682**	.749**	1		
Retention	.378**	.352**	.181**	1	
Graduation	.434**	.426**	.229**	.821**	1

Academic Integration indicators and Institutional Commitment indicators

All indicators for Academic Integration showed statistically significant moderate positive relationships with Institutional Commitment indicators (see Table 35). The relationship tended to be strongest with faculty relationships. Pike's Active scalelet was weak with students ($r = .235$, $p < .001$) and moderate with faculty ($r = .353$, $p < .001$) and administrators ($r = .268$, $p < .001$) and his own support for student success scalelet ($r = .268$, $p < .001$). Pike's collaborative scalelet was moderate with students ($r = .337$, $p < .001$) and his student success scalelet ($r = .392$, $p < .001$) and weak with faculty ($r = .195$, $p < .001$) and administrators ($r = .115$, $p < .001$). Pike's course challenge scalelet was moderate for all four measures. Pike's course interaction scalelet was weak for students ($r = .266$, $p < .001$), moderate for administrators ($r = .397$, $p < .001$) and his student success scalelet ($r = .529$, $p < .001$), and strong for faculty ($r = .742$, $p < .001$). Academic

integration is another term for academic engagement. The Institutional Commitment construct indicators looked at how students are engaged with other students, faculty, and administrators (as well has how well the institution supported their needs, so it follows that there exists a relationship with the two constructs.

Table 35:
Estimated Correlation Matrix Showing Relationships between Academic Integration Indicators and Institutional Support Indicators (N = 497)

	Active	Collaborative	Challenge	Interaction	Students	Faculty	Administration	Support
Active	1							
Collaborative	.062	1						
Challenge	.347**	.295**	1					
Interaction	.673**	.313**	.454**	1				
Students	.235**	.337**	.399**	.266**	1			
Faculty	.550**	.195**	.403**	.742**	.548**	1		
Administration	.353**	.115*	.374**	.397**	.605**	.690**	1	
Support	.268**	.392**	.390**	.529**	.642**	.728**	.642**	1

Institutional Commitment indicators with Intent to Persist

All four Institutional Commitment indicators showed statistically significant moderate positive relationships with both measures of Intent to Persist (see Table 36). Tinto (1987, 1993) added the Intent to Persist construct to his original model (Tinto, 1975) to account for student perceptions of their college experience. Though the indicators were not a perfect representation of the attitude to persist, the moderate correlations suggest that they may have captured at least a piece of that construct.

Table 36:
Estimated Correlation Matrix Showing Relationship between Institutional Commitment Indicators and Intent to Persist Indicators (N = 497)

	Students	Faculty	Administration	Support	Experience	Return
Students	1					
Faculty	.548**	1				
Administration	.605**	.690**	1			
Support	.642**	.728**	.642**	1		
Experience	.506**	.686**	.525**	.685**	1	
Return	.499**	.499**	.496**	.542**	.854**	1

Institutional Commitment indicators with Persistence Indicators

Institutional commitment indicators showed statistically significant weak positive relationships with students and faculty and Pike's support for student success, but showed a weak negative relationship for administrators (see Table 37). Once again, if students associated the library with administrators, the negative relationship does not make sense unless administration was also associated with the barriers many bureaucracies put in place.

Table 37:
Estimated Correlation Matrix Showing Relationship between Institutional Commitment Indicators and Persistence Indicators (N = 497)

	Students	Faculty	Administration	Support	Retention	Graduation
Students	1					
Faculty	.548**	1				
Administration	.605**	.690**	1			
Support	.642**	.728**	.642**	1		
Retention	.034	.012	-.132**	.170**	1	
Graduation	.152**	.209**	-.024	.304**	.821**	1

Intent to Persist with Persistence

Both indicators for Intent to Persist showed statistically significant moderate relationships with retention and graduation (see Table 38). I would have expected larger

correlations, except I suspect that my indicators for the Intent to Persist construct were imperfect.

Table 38:
Estimated Correlation Matrix Showing Relationship between Institutional Commitment Indicators and Intent to Persist Indicators (N = 497)

	Experience	Return	Retention	Graduation
Experience	1			
Return	.854**	1		
Retention	.471**	.357**	1	
Graduation	.557**	.367**	.821**	1

Summary of Correlation Analysis

For the most part, the estimated correlations conformed to expectations. Correlation coefficients between indicators may not always have been as strong as expected, but they generally agreed with the literature. With the notable exception of select Library indicators and the relationship to administration indicator, virtually all of the rest of the indicators showed statistically significant positive relationships with one another. The Library indicator for the ratio of librarians to student showed a positive correlation with every other non-library indicator, but library expenditures, circulation, and instruction all showed negative relationships with select indicators. This suggested that the library measures other than the ratio of librarians to students may not be the most valid observed measures. I therefore used ratios for all four library indicators.

Structural Equation Modeling

Structural Equation modeling tests a hypothesized model. I constructed my model using SPSS AMOS to build a path diagram (see figure 12). Ovals represent latent constructs and the rectangles represent observed variables. Circles represent residual

error in the prediction of each endogenous construct and error terms for each observed variable. Arrows represent the path coefficient for regression of one factor upon another.

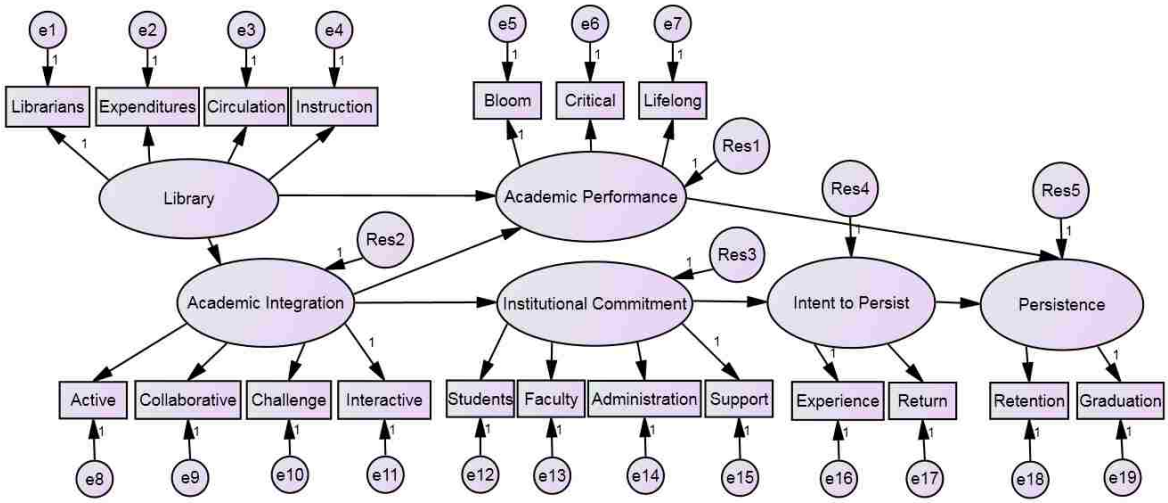


Figure 12: Model 3 – Library Impact on Student Persistence with Indicators

SPSS AMOS first identifies the model. Model identification "focuses on whether or not there is a unique set of parameters consistent in the data" (Byrne, 2010, p. 33). SPSS AMOS calculated estimates and found that Model 2 was inadmissible because the error term for the experience indicator was negative (Error16 = -.007). The most likely explanation for the negative variance is the previously identified collinearity between the experience indicator and the return indicator (.854). This is known as a Heywood Case (Kline, 2005, p. 114). This type of collinearity brings the population correlation too close to 1, causing underidentification. The simplest solution is to remove the indicator from the model. Because I did not want to lose the information in either the return indicator or the experience indicator, I calculated the mean of return and experience to derive a new indicator I called satisfaction.

Since this left the Intent to Return construct with only one indicator, I constrained the error term in order to estimate my model. When there is a single indicator

representing a latent variable, Kline recommends constraining the error term using an *a priori* estimate based upon the literature (Kline, 2005, pp. 229-230). In the original model, Cabrera, Nora, and Castañeda (1993) do not quantify the error term, so I have therefore constrained the error term for the satisfaction indicator to 0. The revised model with the satisfaction indicator replacing the return and experience indicators is illustrated in figure 13 as Model 3A.

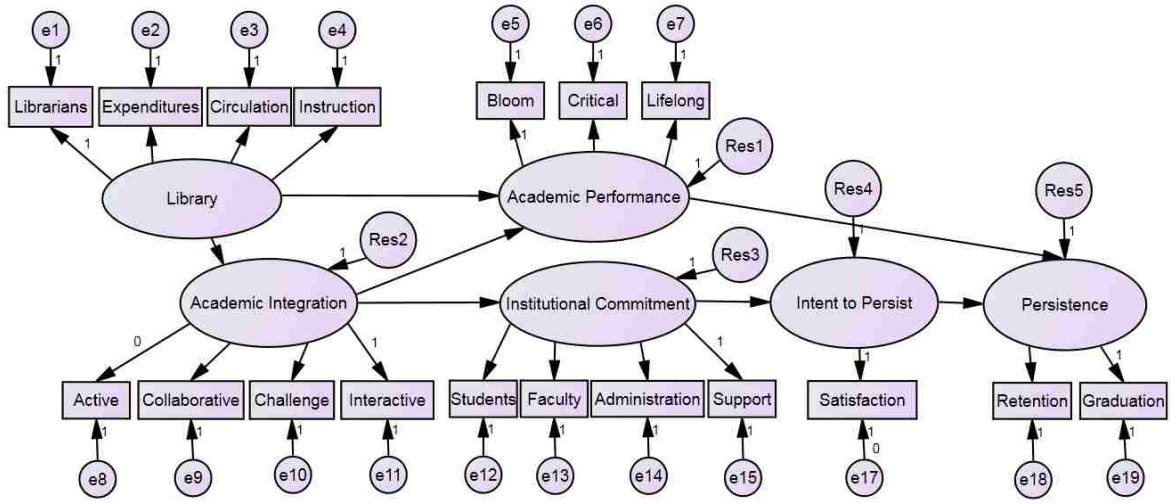


Figure 13: Model 3A – Library Impact on Persistence with Satisfaction indicator

The first step in identifying a model is to add up the number of parameters to be estimated to ensure that the model is overidentified (Byrne, 2010, pp. 33-35). SPSS AMOS determined that the model is overidentified with 129 degrees of freedom.

Goodness of Fit

SPSS AMOS produces an assessment of the overall fit of the model, the measurement model, and the structural model. In Structural Equation Modeling, the null hypothesis that is tested is that the hypothesized model is not significantly different from the observed model. A non-significant p-value ($p > .05$) for the chi square statistic means that you should fail to reject the null hypothesis, leading you to conclude the

hypothesized model is not significantly different from the observed model, and therefore potentially fits. A low p-value means that the model is significantly different from the observed model and likely does not fit. In Model 3A, $p < .001$, meaning that I rejected the null hypothesis that the hypothesized model was not significantly different from the observed model. The overall fit of the model I hypothesized to the observed data was not acceptable and did not fit. This was reflected in a very large chi-square score (1745.9) that represented the difference between the observed covariance matrix and the predicted covariance matrix. Kline called the chi-square the "badness-of-fit index, because the higher its value, the worse the model's correspondence to the data" (Kline, 2005, p. 135).

However, Kline cautioned that a large sample alone can also lead to a large chi-square score and a low p-value. Kline suggested deriving the normed chi-square score by dividing the chi-square by the degrees of freedom. Kline (2005, p. 137) cited Bollen that normed chi-square ratios of up to 3.0 and possibly even 5.0 may indicate a reasonable model fit. The sample was large in my study with nearly 500 cases, it was therefore incumbent on me to calculate the ratio to assess overall goodness-of-fit. In my model, the chi-square was 1756.0 and the degrees of freedom were 129. The resulting normed chi-square of 13.6 was substantially higher than 5.0, meaning that even under this analysis the model fit was still unacceptable.

An examination of the various goodness-of-fit indices confirmed the unacceptable fit. The CFI (Comparative Fit Index) is a non-centrality fit index and the TLI (Tucker-Lewis Index) is a relative fit index. Both are incremental goodness-of-fit indices that compare the hypothesized model with the null model and control for sample size. A good fitting index should score close to one on a 0 to 1 scale with a CFI score greater than .9 or

a TLI score greater than .95. In my model, the values of .735 for CFI and .685 for TLI indicated that the model did not fit. The RMSEA (root mean square error of approximation) is a non-centrality measure of fit that estimates discrepancy per degree of freedom. A good fitting index should score close to zero on a 0 to 1 scale. A good fit would mean that RMSEA would be less than .05, but a model can also have a reasonable fit with scores between .06 and .08 or a poor fit with scores between .08 and .10. In my model, RMSEA = .159, which was an unacceptable fit.

Structural equation modeling is very sensitive to outliers. I calculated the Mahalanobis D^2 statistics, which is a means of identifying multivariate outliers by measuring the distance of each case from the centroid of the distribution. Nine cases in the sample were multivariate outliers with a probability associated with the $D^2 < .001$. An examination of the individual variables showed no apparent pattern, indicating that the most likely explanation was to be found in the combination of the variables. I removed all nine outliers to see if it made a difference in the fit of the model. The result was a slight decrease in the chi-square value (1725.9 versus 1756.0) and no discernible changes in goodness-of-fit scores.

I also checked the data for univariate outliers. Z-Residual scores on retention and graduation revealed two cases with extraordinarily high standard deviations above 5. A closer look at the data associated with each variable showed that both institutions had graduation rates substantially higher than retention rates. When following a single cohort of students this is impossible, as the graduation rate can be at most equal to the retention rate. In this sample, the retention and graduation were not taken from the same cohort, so it was not impossible to have a higher graduation rate, but it was highly unlikely barring

disaster. I removed these two outliers to see if it made a difference in the fit of the model. The result was once again a slight decrease in the chi-square value (1745.9 versus 1756.0) with negligible changes in goodness-of-fit scores.

All of the goodness-of-fit statistics pointed to the conclusion that Model 3A did not describe the nature of the relationship of the library to persistence. I therefore considered a less constrained version of the model.

Model 4

Model 4 was also based upon the Persistence model developed by Cabrera, Nora, and Castañeda (1993). However, instead of hypothesizing that the Library only had a direct impact upon Performance and Academic Integration, I posited that the Library also had a direct impact on the latent variables Institutional Commitment, Intent to Persist, and Persistence itself. Though the literature provides multiple examples of the library's influence on persistence, it does not necessarily make the connection between the library and institutional commitment or the intent to stay in college. It is no stretch of the imagination, however, to make a case that the academic library contributes to a student's sense of institutional commitment. It might be a greater stretch to make the connection that the library bolsters a student's intent to stay in college, but since other research has demonstrated a relationship to persistence, it was worth exploring the idea that the library also influences intent to persist. I also extended the model to include causative paths from Academic Integration to Intent to Persist and Persistence and from Academic Performance to Intent to Persist for similar reasons. See figure 14.

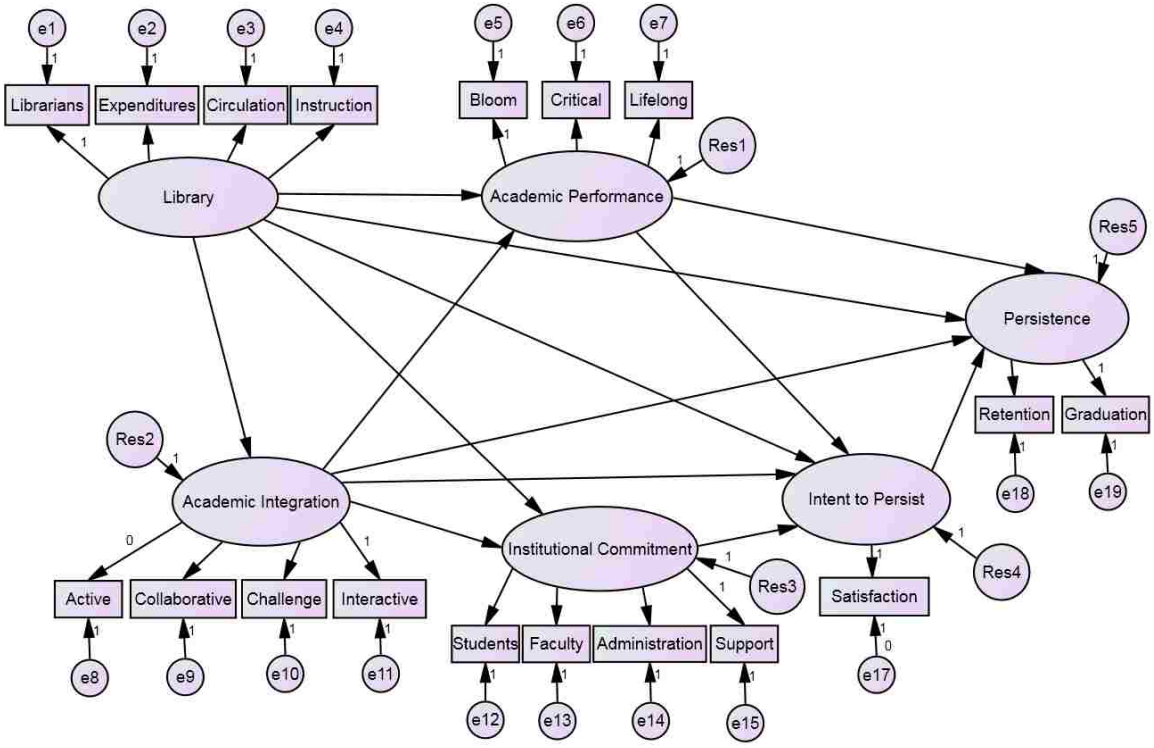


Figure 14: Model 4 – paths unconstrained

Model 4 fit no better than Model 3A. Once again, $p < .001$, which means that once again I rejected the null hypothesis that the hypothesized model was similar to the observed model and I concluded that the model did not fit. The chi-square score was lower than in Model 3A, but remained extremely high at 1415.9 with a normed chi square of 11.5. Goodness-of-fit statistics were also slightly improved but still not good enough to state that the model fit (CFI = .789, TLI = .738, RMSEA = .146).

It was instructive at this point to examine the maximum likelihood parameter estimates. The parameter estimates list the regression weights for the paths between variables. A p-value less than .05 indicates that the relationship is statistically significant. Table 39 shows that all paths were significant except for the relationship between the Library and Intent to Persist (see red highlighted text).

Table 39:
Maximum likelihood parameter estimates for Model 2

			Estimate	S.E.	C.R.	P
Integration	<---	Library	.260	.096	2.703	.007
Performance	<---	Library	.170	.056	3.025	.002
Commitment	<---	Integration	.908	.060	15.072	***
Performance	<---	Integration	.804	.042	19.274	***
Commitment	<---	Library	-.262	.090	-2.921	.003
Intent	<---	Commitment	1.135	.086	13.135	***
Intent	<---	Integration	-2.273	.296	-7.691	***
Intent	<---	Performance	2.365	.301	7.870	***
Intent	**<---**	**Library**	**.171**	**.135**	**1.266**	**.206**
Persistence	<---	Performance	144.721	25.900	5.588	***
Persistence	<---	Intent	14.519	6.296	2.306	.021
Persistence	<---	Library	54.635	13.064	4.182	***
Persistence	<---	Integration	-108.158	19.052	-5.677	***
Librarians	<---	Library	1.000			
Expenditures	<---	Library	2.896	.463	6.254	***
Circulation	<---	Library	3.211	.504	6.375	***
Instruction	<---	Library	1.371	.268	5.123	***
Bloom	<---	Performance	1.000			
Critical	<---	Performance	1.282	.041	31.184	***
Lifelong	<---	Performance	1.017	.044	23.135	***
Interactive	<---	Integration	1.000			
Challenge	<---	Integration	.803	.050	16.068	***
Collaborative	<---	Integration	.527	.062	8.530	***
Active	<---	Integration	.000			
Support	<---	Commitment	1.000			
Administration	<---	Commitment	1.920	.096	19.925	***
Faculty	<---	Commitment	1.749	.074	23.650	***
Students	<---	Commitment	1.076	.064	16.834	***
Graduation	<---	Persistence	1.000			
Retention	<---	Persistence	.665	.028	23.730	***
Satisfaction	<---	Intent	1.000			

*** < .001

I therefore removed the path from Library to Intent to Persist from the model. See Figure 15 for Model 4A.

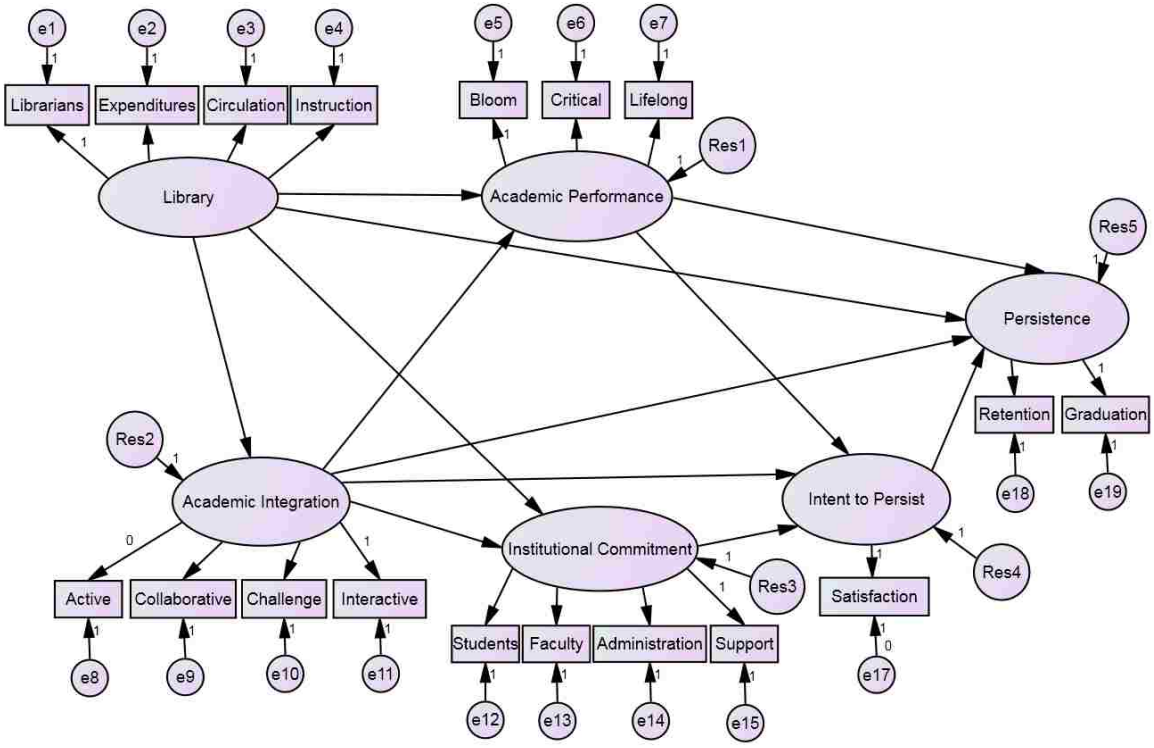


Figure 15: Model 4A – paths unconstrained with path removed from Library to Intent to Persist

Though loosening the constraints on the model by adding paths did not lead to a model that fit, it was still possible to further modify the model by adding additional paths. Modification indices estimate how much improvement would result by adding additional paths to the model. Table 40 lists only paths that would improve the chi-square score by at least 25 points if added to the model.

Table 40:
Modification Indices for Model 3A

		M.I.	Par Change
Retention	<--- Integration	28.508	-11.414
Retention	<--- Commitment	34.419	-11.320
Retention	<--- Faculty	43.010	-6.036
Retention	<--- Interactive	27.428	-9.358
Graduation	<--- Integration	38.698	22.153
Graduation	<--- Commitment	47.154	22.077
Graduation	<--- Faculty	57.580	11.634
Graduation	<--- Support	39.580	15.802

			M.I.	Par Change
Graduation	<---	Interactive	34.974	17.602
Graduation	<---	Librarians	28.114	9.670
Students	<---	Interactive	34.621	-.312
Faculty	<---	Active	42.249	.273
Faculty	<---	Interactive	61.916	.357
Faculty	<---	Librarians	28.194	.148
Administration	<---	Library	28.547	-.785
Administration	<---	Persistence	40.172	-.005
Administration	<---	Retention	35.063	-.006
Administration	<---	Graduation	44.920	-.004
Administration	<---	Bloom	33.580	-.496
Support	<---	Persistence	35.940	.002
Support	<---	Retention	34.196	.003
Support	<---	Graduation	33.191	.002
Support	<---	Active	30.474	-.171
Support	<---	Collaborative	45.156	.201
Active	<---	Library	38.890	-.440
Active	<---	Support	28.222	-.157
Active	<---	Collaborative	36.353	-.189
Active	<---	Expenditures	37.326	-.128
Collaborative	<---	Library	25.443	.484
Collaborative	<---	Persistence	54.080	.004
Collaborative	<---	Retention	47.378	.004
Collaborative	<---	Graduation	56.193	.003
Challenge	<---	Intent	33.741	.178
Challenge	<---	Satisfaction	33.741	.178
Challenge	**<---**	**Critical**	**36.079**	**.213**
Bloom	<---	Commitment	23.215	-.102
Bloom	<---	Intent	37.336	-.102
Bloom	<---	Satisfaction	37.336	-.102
Bloom	<---	Students	45.781	-.087
Bloom	<---	Administration	36.661	-.049
Bloom	<---	Support	27.089	-.086
Bloom	<---	Active	40.782	.116
Librarians	**<---**	**Integration**	**81.887**	**.756**
Librarians	**<---**	**Commitment**	**69.358**	**.628**
Librarians	**<---**	**Performance**	**58.544**	**.723**
Librarians	**<---**	**Faculty**	**82.301**	**.326**
Librarians	**<---**	**Support**	**54.974**	**.437**
Librarians	**<---**	**Challenge**	**33.384**	**.410**
Librarians	**<---**	**Interactive**	**84.181**	**.641**

			M.I.	Par Change
Librarians	**<---**	**Lifelong**	**43.782**	**.494**
Librarians	**<---**	**Critical**	**50.817**	**.492**
Librarians	**<---**	**Bloom**	**38.139**	**.506**

I was intrigued by the size of the modification index linking critical thinking to challenge (see red highlighted text). I built the Academic Integration construct with four of Pike's scalelets related to engagement. However, academic challenge has also been linked to higher performance, so I thought it worthwhile to test the idea by linking the indicator Challenge to Academic Performance instead. I was also intrigued by the high modification index scores for paths from multiple variables to the librarians indicator (see green highlighted text). This suggested that the librarian index might have the strongest impact among library indicators. I therefore moved the challenge indicator to academic performance and retained only the librarians indicator for the Library construct. As a result, the Library construct no longer held a statistically significant relationship at the .05 level with Institutional Commitment ($p = .091$). Though exploratory research might allow me to relax the $< .05$ standard to $<. 1$, I elected nonetheless to remove the path from the Library construct to the Institutional Commitment construct. See figure 16 for Model 4B.

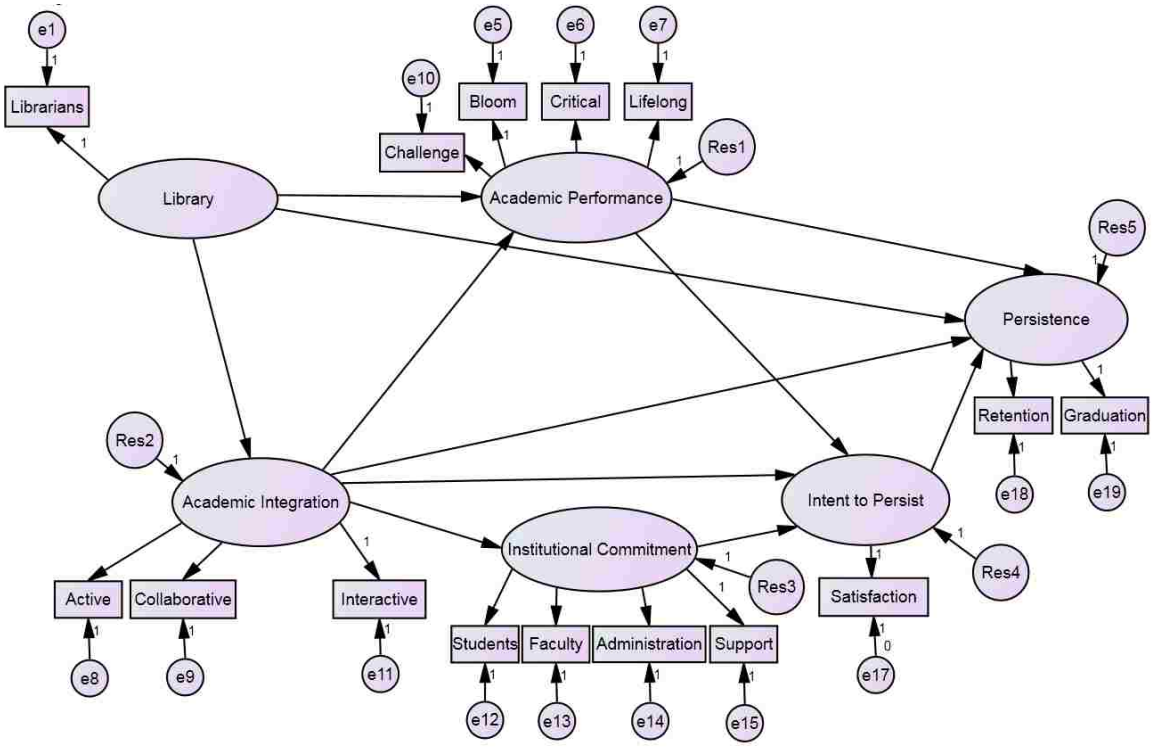


Figure 16: Model 4B – paths unconstrained with path removed from Library to Intent to Persist and Librarians as sole indicator for Library

Model 4B fit no better than Models 3A or 4A. The p-value for the chi square statistic remained statistically significant ($P < .001$), indicating once again that I must reject the null hypothesis and determine that the model does not fit. The chi-square was reduced at 1154.2 but with a higher normed chi-square of 14.2. Goodness-of-fit statistics were virtually the same (CFI = .813, TLI = .758, RMSEA = .163).

None of the models fit. The hypothesized model differed too greatly from the measured model in the sample. Adjustments to the model to loosen constraints by modifying paths and altering indicators made only slight improvements in fit. The models all failed to explain how the academic library fits into existing models of student persistence. Before rejecting the model completely, however, it was worth scrutinizing

the subset of the original model to see if it fit in this sample using NSSE measures as indicators.

Model 5

Model 5 was a subset of the original path diagram developed by Cabrera, Nora, and Castañeda (1993) without the addition of the Library construct. See figure 17.

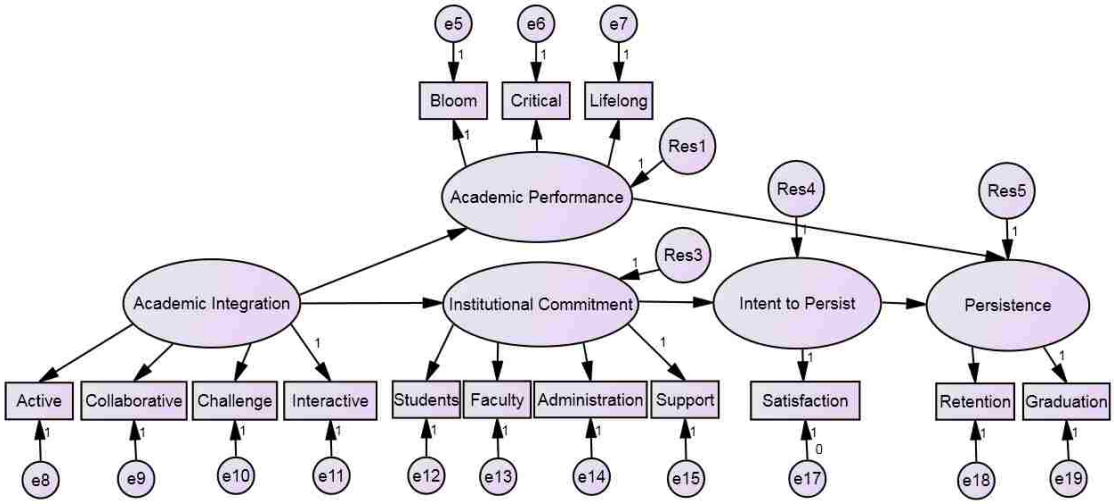


Figure 17: Model 5: Subset of Cabrera, Nora, and Castañeda (1993) model with indicators

In their final best fitting model, Cabrera, Nora, and Castañeda (1993) reported a p-value of < .05 and a chi-square of 201.18, which I calculated as a normed chi-square of 2.14. The chi square statistic was statistically significant, which meant it is possible that their model did not fit. However, the normed chi-square (which was not a measure that they reported) was below 3, meaning that the model might indeed fit, making it worth considering additional measures. They utilized goodness-of-fit statistics commonly used in structural equation modeling at the time they conducted their research. The GFI (Goodness of Fit Index) and AGFI (Adjusted Goodness of Fit Index) are absolute fit indices derived from the covariance matrices with the AGFI adjusting for degrees of freedom. Scores should approach one on a 0 to 1 scale and should be above .95. The

Cabrera model met that threshold (GFI = .970, AGFI = .957). RMR (Root Means Residual) is an absolute fit index that measures the residual from the covariance matrices. The RMR needs to be "interpreted in the metric of the correlation matrix" (Byrne, 2010, p. 77), but should approach zero on a 0 to 1 scale, preferably less than .05. The Cabrera, Nora, and Castañeda (1993) model was borderline acceptable (RMR = .072).

For my sample, with a different set of indicators underlying their constructs, the model did not fit. The chi-square statistic was 1500.0 ($p < .001$) with a normed chi-square of 20.5. The goodness-of-fit statistics indicated lack of model fit, whether using the goodness-of-fit indices Cabrera used originally (GFI = .682, AGFI = .542, RMR = .632) or the indices used in this study (CFI = .745, TLI = .682, RMSEA = .199). Moving the Challenge indicator to Academic Performance improved the goodness-of-fit measures marginally, but not enough to fit the model.

There are three plausible explanations why the Cabrera, Nora, and Castañeda (1993) model did not fit. First is the fact that my model looked only at the academic factors explaining why students persist. Cabrera, Nora, and Castañeda (1993) also included social factors such as encouragement and social integration and personal factors such as financial attitudes and goal commitment. See figure 18.

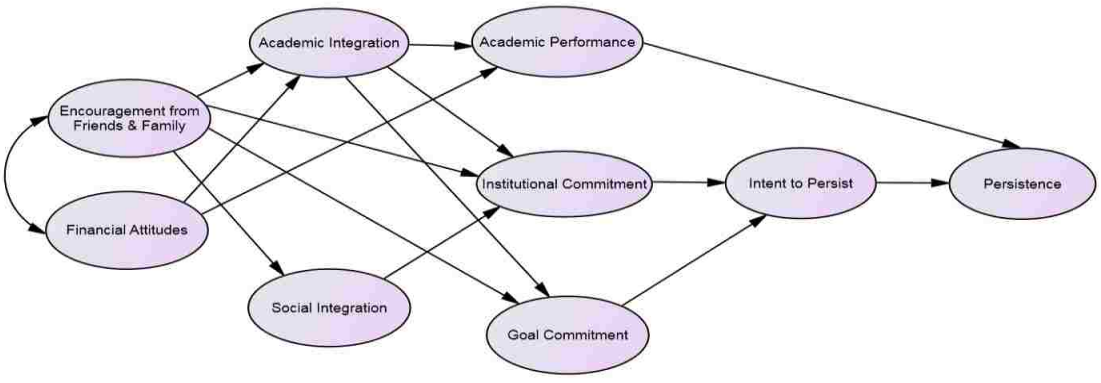


Figure 18: Model 1 – Cabrera, Nora, and Castañeda (1993) model

Social and personal factors may be so critical to student persistence that leaving them out may very well invalidate the model. Academic factors alone may not be enough to explain student persistence.

Second is that the measures I used for each latent construct differed from the ones used by Cabrera, Nora, and Castañeda (1993). I adapted engagement measures from the National Survey of Student Engagement while they developed their own questionnaire. See Table 41 for a comparison of the concepts underlying each construct.

Table 41:
Comparison of Cabrera, Nora, and Castañeda (1993) *and Emmons Indicators*

Academic Performance	
Cabrera, Nora, and Castañeda	*Emmons*
GPA	Bloom's Taxonomy
	Critical thinking
	Lifelong learning
Academic Integration	
Cabrera, Nora, and Castañeda	*Emmons*
Anticipation of academic performance	Active learning
Satisfaction with academic experience	Collaborative learning
Satisfaction with course curriculum	Challenging courses
	Interactive learning
Institutional Commitment	
Cabrera, Nora, and Castañeda	*Emmons*
Confidence on institutional choice	Relationships with other students
Institutional Fit and Quality	Relationships with faculty
	Relationships with administrators
	Institutional support
Intent to Persist	
Cabrera, Nora, and Castañeda	*Emmons*
Likely to re-enroll	Satisfaction
Persistence	
Cabrera, Nora, and Castañeda	*Emmons*
Re-enrollment at the institution	Retention rate at institution
	Graduation rate at institution

Third is the fact that the Cabrera, Nora, and Castañeda (1993) study asked questions of individual students while my study analyzed data at the institutional level. There is a distinct possibility that connections and relationships are lost when figures are

aggregated. The return of an individual student who is well integrated into the academic life of campus for a second year of school may not be reflected in the overall retention rates for their students. This is particularly true if the original sample was not truly random.

Regardless of the explanation, the Cabrera model did not fit this sample with these indicators. It was therefore worth exploring whether these observed measures showed a relationship to student persistence using multiple regression.

Multiple Regression

I fit a taxonomy of multiple regression models in order to analyze the relationships between the dependent variable of graduation and the independent variables from the SEM model. For the library, I used ratios for all four variables. I also wanted to measure the combined impact of the variables used to describe each construct in my original model. Note that I used only experience as an Intent to Persist variable, as it was too collinear with return to include both (r = .854). See Table 42 for the list of variables included in each model.

Table 42:
A Taxonomy of Multiple Regression Models Where Graduation Rate is the Outcome

Model	Variables Entered
1	Instruction, Librarians, Circulation, Expenditures
2	Variables from Model 1 plus Bloom, Critical, Lifelong
3	Variables from Model 2 plus Active, Challenge, Collaborative, Interactive
4	Variables from Model 3 plus Students, Faculty, Administration, Support
5	Variables from Model 5 plus Experience

Table 43 summarizes the R-square statistics for each model presented in Table 42. The R-square statistic shows what percent of the variation in graduation rate from

institution-to-institution is predicted by the set of variables in the model. The change in the R-square statistic from model to model was statistically significant (the corresponding F statistics and p values are reported in Table 43).

Based on Model 1, the library variables accounted for 16.8% of the variation in the graduation rate from institution to institution. Each subsequent addition of a set of variables added predictive power to the model, with the variables in the final model accounting for 55.1% of the institution-to-institution variation in graduation rates.

Table 43:
Model Summary of a Taxonomy of Multiple Regression Models on Graduation

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.410	.168	.161	15.466	.168	24.866	4	492	.000
2	.552	.305	.295	14.177	.137	32.156	3	489	.000
3	.622	.386	.373	13.378	.081	16.048	4	485	.000
4	.667	.445	.427	12.780	.058	12.616	4	481	.000
5	.742	.551	.536	11.500	.107	114.026	1	480	.000

While the variables in a block taken together were statistically significant (all p-values < .001 for the changes in the F statistic), not all estimated regression coefficients were statistically significant (see Table 44).

In model 5 – the model that interests me because it included all observed measures from the hypothesized model I tested with SEM – expenditures, circulation, and instruction were not statistically significant, leaving only librarians as a statistically significant predictor. Other estimated coefficients that were not statistically significant included active, students, and faculty.

Table 44:
Estimated regression coefficients of each variable where graduation is the outcome

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	51.561	13.719		3.758	.000
	Librarians	15.200	3.089	.213	4.920	.000
	Expenditures	15.517	3.742	.222	4.147	.000
	Circulation	2.345	2.208	.053	1.062	.289
	Instruction	5.122	2.480	.090	2.065	.039
2	(Constant)	-105.748	23.331		-4.533	.000
	Librarians	7.203	3.021	.101	2.384	.018
	Expenditures	13.222	3.453	.189	3.828	.000
	Circulation	1.601	2.041	.036	.785	.433
	Instruction	3.268	2.282	.057	1.432	.153
	Bloom	43.723	9.385	.319	4.659	.000
	Critical	27.021	8.922	.234	3.028	.003
	Lifelong	-26.788	7.345	-.215	-3.647	.000
3	(Constant)	-75.649	24.578		-3.078	.002
	Librarians	10.769	2.980	.151	3.614	.000
	Expenditures	7.125	3.366	.102	2.117	.035
	Circulation	1.767	1.933	.040	.914	.361
	Instruction	1.799	2.168	.031	.830	.407
	Bloom	70.474	10.274	.514	6.859	.000
	Critical	19.491	9.050	.169	2.154	.032
	Lifelong	-13.220	7.334	-.106	-1.803	.072
	Active	-17.080	6.037	-.158	-2.829	.005
	Collaborative	21.635	4.272	.208	5.064	.000
	Challenge	-11.261	5.871	-.095	-1.918	.056
	Interactive	-22.639	7.242	-.194	-3.126	.002

4	(Constant)	-123.046	25.941		-4.743	.000
	Librarians	7.622	2.912	.107	2.618	.009
	Expenditures	7.258	3.236	.104	2.243	.025
	Circulation	1.010	1.859	.023	.544	.587
	Instruction	3.060	2.079	.054	1.472	.142
	Bloom	79.351	10.643	.579	7.456	.000
	Critical	6.334	9.302	.055	.681	.496
	Lifelong	-14.900	7.423	-.119	-2.007	.045
	Active	-15.434	6.070	-.143	-2.543	.011
	Collaborative	16.062	4.650	.154	3.454	.001
	Challenge	-7.691	5.966	-.065	-1.289	.198
	Interactive	-42.799	8.772	-.367	-4.879	.000
	Students	4.958	4.120	.065	1.203	.229
	Faculty	14.560	4.900	.242	2.971	.003
	Administration	-12.378	2.688	-.257	-4.604	.000
	Support	22.580	6.127	.229	3.685	.000
5	(Constant)	-93.742	23.503		-3.988	.000
	Librarians	7.677	2.620	.107	2.930	.004
	Expenditures	4.683	2.922	.067	1.603	.110
	Circulation	.874	1.673	.020	.522	.602
	Instruction	2.401	1.872	.042	1.283	.200
	Bloom	59.248	9.760	.432	6.070	.000
	Critical	-21.163	8.758	-.183	-2.417	.016
	Lifelong	-19.811	6.695	-.159	-2.959	.003
	Active	.718	5.668	.007	.127	.899
	Collaborative	13.655	4.190	.131	3.259	.001
	Challenge	-11.282	5.379	-.095	-2.097	.036
	Interactive	-21.717	8.137	-.186	-2.669	.008
	Students	2.869	3.713	.038	.773	.440
	Faculty	-4.504	4.757	-.075	-.947	.344
	Administration	-13.927	2.424	-.289	-5.746	.000
	Support	11.185	5.616	.114	1.992	.047
	Experience	66.413	6.219	.681	10.678	.000

A similar process to fit a taxonomy of multiple regression models on retention instead of graduation (not illustrated here) left expenditures as the only statistically

significant library measure. I therefore fit an additional model, Model 6, by removing all variables that were not statistically significant (circulation, instruction, active, students, faculty), keeping expenditures as part of the model.

Table 45:
Model 6 Summary

Model	**R**	R Square	Adjusted R Square	Std. Error of the Estimate
6	.740	.548	.538	11.480

Taken together, the variables in Model 6 accounted for 54.5% of the institution-to-institution variation in graduation rates. Table 46, shows that Challenge was no longer statistically significant at the .05 level.

Table 46:
Estimated regression coefficients for Model 6

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	-99.418	20.651		-4.814	.000
	Librarians	7.060	2.579	.099	2.737	.006
	Expenditures	6.440	2.397	.092	2.686	.007
	Bloom	60.024	8.654	.438	6.936	.000
	Critical	-22.481	8.619	-.195	-2.608	.009
6	Lifelong	-18.218	6.313	-.146	-2.886	.004
	Collaborative	15.892	3.725	.152	4.266	.000
	Challenge	-9.791	5.146	-.083	-1.903	.058
	Interactive	-26.502	5.854	-.227	-4.527	.000
	Administration	-14.302	2.154	-.297	-6.641	.000
	Support	10.795	5.155	.110	2.094	.037
	Experience	64.737	5.567	.664	11.628	.000

Once again, though it is acceptable in this type of exploratory study to retain a variable where the p value is less than .1, I decided to remove Challenge (p = .059) from the model. Table 47, with Challenge removed, summarizes Model 6A.

Table 47:
Model 6A Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
6A	.738	.545	.535	11.511

Model 6A accounted for 54.1% of the variance in graduation. The estimated regression coefficients (see Table 46) told us that, controlling for Bloom, critical, lifelong, collaborative, interactive administration, support, and experience, librarians and library expenditures had a positive influence on graduation rates. See Table 48.

Table 48:
Estimated Regression Coefficients for Model 6A where Graduation Rate is the dependent variable

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
6A	(Constant)	-112.897	19.450		-5.804	.000
	Librarians	6.760	2.581	.095	2.619	.009
	Expenditures	6.629	2.402	.095	2.760	.006
	Bloom	58.582	8.644	.428	6.777	.000
	Critical	-26.294	8.406	-.228	-3.128	.002
	Lifelong	-20.126	6.250	-.161	-3.220	.001
	Collaborative	15.215	3.718	.146	4.092	.000
	Interactive	-25.678	5.854	-.220	-4.386	.000
	Administration	-15.097	2.118	-.313	-7.126	.000
	Support	11.630	5.151	.118	2.258	.024
	Experience	64.456	5.580	.661	11.551	.000

I tested Model 6A for any unusual or influential cases. I calculated PRESS residuals, HAT statistics, Cook's Distance, and covariance ratio, which are tests that detect atypical data points, to find cases that fall well outside the model. By further examining the scatterplots of unstandardized predicted value against standardized residual and case number against studentized deleted residual, centered leverage value,

Cook's Distance, and covariance ratio, I found three cases that were extreme on Y (all three were among the four cases whose residuals exceeded 3 standard deviations). I refit the model by excluding each institution in turn and found that the most significant change in effects on GRAD occurred when two institutions were excluded. See Appendix C for my calculations.

A closer examination of the descriptive statistics revealed why the cases might have been overly influential. In both cases, graduation rates were right at the top of the sample, yet students reported low scores for the academic performance indicators of Bloom's taxonomy and critical thinking. One institution had among the highest library expenditures and the highest ratio of librarians to students to go along with high ratings for administration and support. The other institution had low scores for overall experience. In other words, despite either low academic performance or overall experience ratings, these two institutions still maintained the highest graduation rates in the sample. I therefore refit the model once more by excluding both institutions. See Table 49.

Table 49:
Model 6B Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
6B	.764	.583	.574	10.933

Model 6B accounted for 58.3% of the variance in graduation. The estimated regression coefficients (see Table 50) demonstrated that, controlling for Bloom, critical, lifelong, collaborative, interactive administration, support, and experience, librarians and library expenditures had a positive influence on graduation rates in the sample.

Table 50:
Estimated Regression Coefficients for Model 6B

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
6B	(Constant)	-123.759	18.545		-6.674	.000
	Librarians	5.117	2.476	.071	2.066	.039
	Expenditures	5.149	2.301	.074	2.238	.026
	Bloom	63.240	8.243	.464	7.672	.000
	Critical	-26.364	7.995	-.230	-3.298	.001
	Lifelong	-22.062	5.948	-.179	-3.709	.000
	Collaborative	14.823	3.535	.144	4.194	.000
	Interactive	-27.122	5.567	-.234	-4.872	.000
	Administration	-16.088	2.031	-.333	-7.920	.000
	Support	10.200	4.906	.104	2.079	.038
	Experience	69.046	5.350	.712	12.906	.000

The largest positive impact on graduation, controlling for all other predictors in Model 6B, was overall experience – this is fitting, as a positive overall experience is likely to encourage a student to stay in school. Similarly, when controlling for all other predictors in the model, Bloom's Taxonomy had a strong positive impact on graduation rates. Since Bloom's Taxonomy is a measure of how much students are asked to think and an indicator for academic performance, it makes sense that students graduate at higher levels. Collaborative learning and institutional support each had a smaller but still positive impact on graduation rates as well. As collaborative learning is a measure of working with other students and support is a measure of how much the student perceives the institution supports their success, both numbers should have an impact on staying in school.

At first blush it seems odd that, controlling for all other variables, self-assessed critical thinking may have a negative influence upon graduation ($\beta_4 = -26.364$), but on

further reflection challenging classes that ask students to utilize higher order thinking skills could make completing school more difficult. It is more difficult to explain the estimated negative coefficient for interactive courses. It seems counterintuitive that an interactive course would make it more difficult to graduate.

As noted above, there is a relationship between both librarians and library expenditures and graduation. In order to control for the influence of non-library variables, I solved the linear equation for model 6B. In the equation, β_0 is the intercept or constant, β_1 is librarians, β_2 is library expenditures, β_3 is Bloom's taxonomy, β_4 is critical thinking, β_5 is lifelong learning, β_6 is collaborative learning, β_7 is interactive learning, β_8 is administrative relations, β_9 is support for student success, and β_{10} is overall experience. Inserting the estimated regression coefficients produced the following linear equation:

$$\widehat{GRAD} = -112.509 + 5.117\beta_1 + 5.149\beta_2 + 63.240\beta_3 - 26.364\beta_4 - 22.062\beta_5 + 14.823\beta_6 - 27.122\beta_7 - 16.088\beta_8 + 10.200\beta_9 + 69.046\beta_{10}$$

I solved for $\widehat{GRAD}$ by holding all independent variables at their means:

$$\widehat{GRAD} = -112.509 + 5.117*-2.554 + 5.149*2.653 + 63.240*3.052 - 26.364*3.299 - 22.062*2.961 + 14.823*2.202 - 27.122*2.521 - 16.088*4.714 + 10.200*2.487 + 69.046*3.234 = 54.65\% \text{ estimated graduation rate}$$

Model 6B predicts a 54.65% graduation rate when all independent variables are held at their means. My interest was in seeing the impact of the two library measures, so I solved two separate linear equations in order to analyze the effect they had upon estimated graduation rates.

In the first equation, I calculated the effect that the librarian variable had upon estimated graduation rates by holding all variables to their means except for the librarian variable:

$$GR\hat{A}D = -112.509 + 5.117*\beta_1 + 5.149*2.653 + 63.240*3.052 - 26.364*3.299 - 22.062*2.961 + 14.823*2.202 - 27.122*2.521 - 16.088*4.714 + 10.200*2.487 + 69.046*3.234$$

Figure 19 illustrates the results as a prototypical plot. The y-axis shows the estimated graduation rate. The x-axis shows the ratio of students per librarian. Note that I calculated the plot using the Log10 of the ratio of librarians to students, but that I labeled the x-axis with the ratio of students per librarian to make interpretation more straightforward and understandable. The figure illustrates that, holding all other variables in the model constant, a decrease in the ratio of students per librarian predicts an increase in the estimated graduation rate. Inserting the lowest librarian value from the sample of one librarian serving 1,250 students (-3.10, log base 10) into the equation produces an estimated graduation rate of 51.86 percent and inserting the highest librarian value of one librarian serving 52 students (-1.70, log base 10) into the equation produces an estimated graduation rate of 58.92 percent.

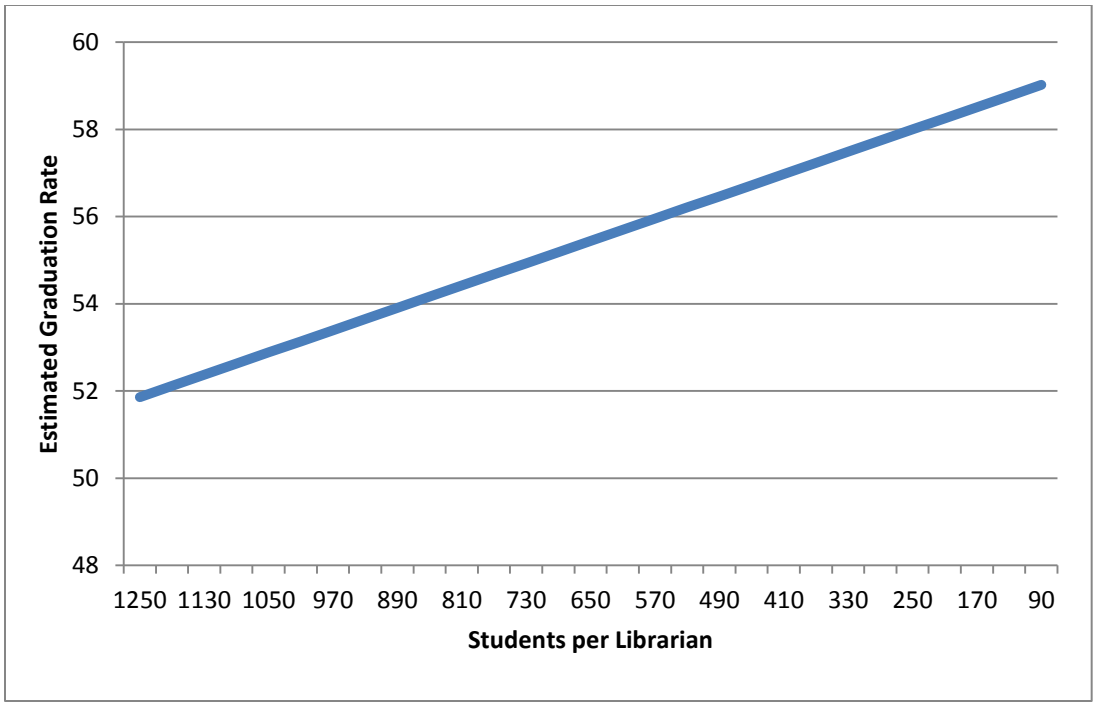


Figure 19: Prototypical plot for Model 6B where all variables are held at their means and Log10 ratio of librarians to students varies from its minimum (-3.10, log base 10) to its maximum (-1.70, log base 10). X-axis displayed as actual number of students per librarian

The difference in the estimated graduation rate between the lowest value and the highest value in the sample was 7.06 percentage points, indicating that the ratio of librarians to students does make a difference in estimated graduation rates.

The same held true for library expenditures. In the second equation, I calculated the effect that the library expenditures variable has upon estimated graduation rates by holding all variables to their means except for the expenditures variable:

$$GR\hat{A}D = -112.509 + 5.117*-2.554 + 5.149*\beta_2 + 63.240*3.052 - 26.364*3.299 - 22.062*2.961 + 14.823*2.202 - 27.122*2.521 - 16.088*4.714 + 10.200*2.487 + 69.046*3.234$$

Figure 20 illustrates the results. Once again, the y-axis shows the estimated graduation rate. In Figure 20, I calculated the plot using the Log10 of the ratio of expenditures per

student, but labeled the x-axis with the actual expenditures per students to make interpretation more clear-cut. An increase in the ratio of expenditures per student predicts an increase in the estimated graduation rate. Inserting the lowest expenditures value of $139 per student in the equation resulted in an estimated graduation rate of 52.01 percent and inserting the highest expenditures value of $2,211 per student in the equation resulted in an estimated graduation rate of 58.19 percent.

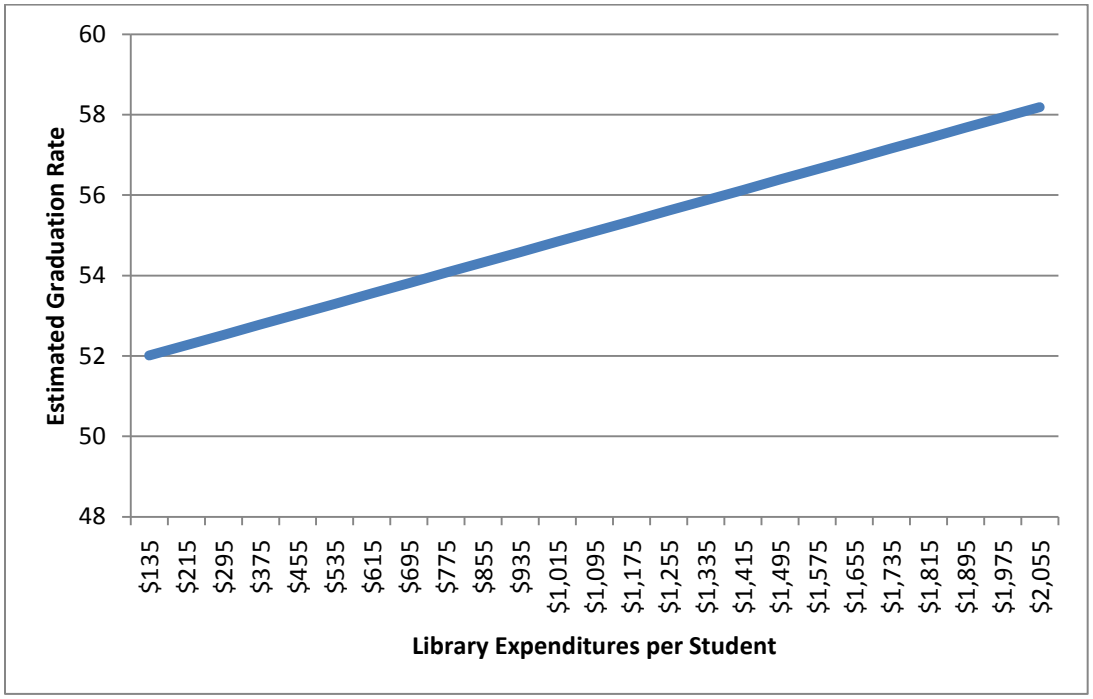


Figure 20: Prototypical plot for Model 6B where all variables are held at their means and Log10 ratio of expenditures students varies from its minimum (2.14, log base 10) to its maximum (3.34, log base 10). X-axis displayed as actual expenditures per student.

Though the difference in the estimated graduation rate between the lowest value and the highest value in the sample was lower than the difference for the librarian ratio, the 6.18 percentage point difference indicated that the ratio of expenditures per student also makes a difference in estimated graduation rates.

In addition, I estimated graduation rates for the combined low and high values of librarians and expenditures while holding all non-library independent variables at their

means. Inserting the lowest librarian and expenditures values in the equation produced an estimated graduation rate of 49.22 percent and inserting the highest librarian expenditures values in the equation produced an estimated graduation rate of 62.46 percent. Here, the difference was substantial, at 13.24 percentage points, suggesting that a combination of librarians and library expenditures positively influences graduation rates.

As the ratio of librarians to students and library expenditures per student increases, the graduate rate is predicted to be higher when holding the indicators for academic performance, academic integration, institutional commitment, and intent to persist constant.

Another way to interpret the results is to examine the unstandardized coefficients for the two library indicators. The interpretation of the unstandardized coefficients (see Table 46) means that, controlling for all other predictors in the model, for every one unit change in the Log10 ratio of librarians to students, we would predict a 5.117 percentage point change in graduation rate, and for every one unit change in Log10 expenditures per student we would predict a 5.149 percentage point change in graduation.

However, because both library variables were transformed with Log10, it is difficult to interpret these estimated betas. To make the estimated regression coefficient more meaningful and to calculate its impact, I applied the following formula: β_1 * log10 (X), where β_1 is the estimated regression coefficient and X is the percentage change. For librarians, Inserting β_1 and a 10 percent increase into the equation yields Librarians = 5.117 * log10 (1.1) = 0.405%. In other words, in the population from which the sample was drawn, controlling for all the other predictors in the model, a 10 percent increase in the ratio of professional library staff to students predicts a 0.405 percent increase in

graduation rates. Note that this figure is substantially lower than the 1.55 percent increase calculated by Emmons and Wilkinson (2011) in a similar study that controlled for race/ethnicity and financial aid. This study is different, in that it includes other factors that contribute to graduation including measures of academic performance, academic integration, institutional commitment, and intent to persist.

Using the same formula for expenditures, Inserting β_2 and a 10 percent increase into the equation generates Expenditures = 5.149 * log10 (1.1) = 0.408%. In other words, in the population from which the sample was drawn, and controlling for measures of student engagement related to academic performance, academic integration, institutional commitment, and intent to persist, a 10 percent increase in the ratio of library expenditures per student predicts a 0.408 percent increase in graduation rates.

For both librarians and library expenditures, the relationship is curvilinear. For example, while the first 10 percent increase in the ratio of professional staff to students predicts a .405 percent increase in graduation, an additional 10 percent increase only predicts an additional .178 percent increase in graduation rates. The predicted impact from changes in the ratio of librarians and library expenditures per student are virtually identical as illustrated by the overlapping curves in figure 21.

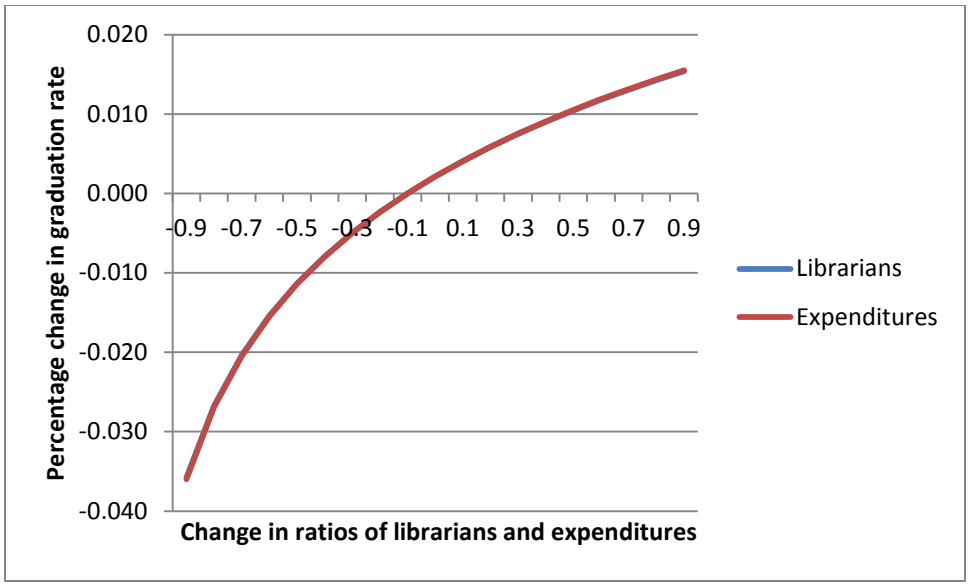


Figure 21: Predicted Impact of a Change in the Ratios of Librarians and Expenditures to Students on Graduation Rates

Discussion

The fitted model from a multiple linear regression analysis predicts that, controlling for all other variables in the model, an increase in the ratio of librarians to students predicts a modest increase in graduation rates. Though the numbers are not as large, these results echo the findings from a previous study I conducted with Wilkinson (Emmons & Wilkinson, 2011). New to the findings from our original study is that the same holds true for expenditures per student ratio.

My interest in pursuing structural equation modeling grew out of that study. In the conclusion, we speculated that a likely reason that an increase in the ratio of librarians to students predicted an increase in retention and graduation rates was likely due to the fact that the ratio was collinear with other factors. Though I did not control for all possible factors, this study did control for factors that have been shown to impact persistence such as academic performance, academic integration, institutional commitment, and intent to persist. The result was a smaller impact by the library, but an impact nonetheless.

We also conjectured that the library did not have a direct impact, but that it was instead indirect and mediated by other factors. The structural models I hypothesized were designed to test potential mediating factors. Unfortunately, despite a strong theoretical foundation and the results from a taxonomy of multiple linear regression models suggesting that the library measures have predictive power, none of the structural equation models fit, and so I was left to explore the reasons why.

CHAPTER 5:

CONCLUSIONS

What impact does the academic library have on student persistence?

Based on fitting a taxonomy of multiple linear regression models, I found that, holding a vector of institutional variables constant, a change in the ratio of librarians to students predicts a change in graduation rates. My finding reinforces the findings of a previous study I conducted with Wilkinson (Emmons & Wilkinson, 2011) and adds the conclusion that a change in library expenditures per student also predicts a change in graduation rates.

These findings brought me full circle, as my original interest in developing a model of the library impact on student persistence that I could test with structural equation modeling grew out of that study. In that first study, we were also interested in the impact that the academic library had upon student success. When we found that librarians did make a difference, we were excited. But, we were left to speculate as to the causes. We reasoned that one likely explanation that an increase in the ratio of librarians to students predicted an increase in retention and graduation rates was due to the fact that the library input and output measures correlated with other factors. We concluded that the library did not have a direct impact, but that it did have an indirect impact mediated by other factors. I was interested in what those factors might be and began my investigation.

I made a thorough search of the literature and discovered that several models of student persistence had emerged from Astin (1977, 1993), Tinto (1987, 1993), and Bean and Metzner (1985), and that these last two models had been merged and tested by Cabrera, Nora, and Castañeda (1993) using structural equation modeling. Their model

included three factors that the literature had shown to be correlated with library measures: academic performance, academic integration, which is a concept similar to academic engagement, and persistence. As a result, I felt comfortable hypothesizing a model that added the library. Because the library related only to those three factors, I decided to test only a subset (see figure 22) of the entire Cabrera, Nora, and Castañeda model. I have presented Model 2 before, but I present it again in figure 22.

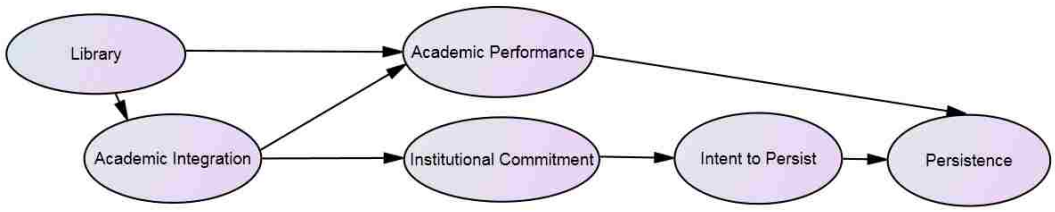


Figure 22: Model 2

I chose indicators that differed from those used by Cabrera, Nora, and Castañeda (1993) because my study was multi-institutional and I needed to use existing data. I chose to conduct the analyses at the institutional level rather than the individual level. Unfortunately, despite a strong theoretical foundation and a taxonomy of linear regression models that include multiple, statistically significant predictors of graduation rate, none of the structural equation models fit. I was left to explore the reasons why my structural equation models did not describe the nature of the relationship of the library to persistence.

Measurement

There is a distinct possibility that I used measures that were imperfect. The indicators for the library construct, in particular, were debatable. What do the number of librarians, the amount spent on the budget, the number of items circulated, and the number of classes taught by librarians truly tell us about the library? First, these variables

tell us about a library's resources. A large library on a large campus is likely to hire more librarians who teach more classes and buy books that will get checked out by a larger number of students. I adjusted for this possibility by developing ratios per student for each variable, but this did not change the fact that the observed measure relied on a factor related more to size than to quality. Second, if the campuses were not large or did not serve more students, but still had large ratios, it is likely that the variables tell us about the library's resources in a different way. In these circumstances, it is likely that the library is wealthy and the institution is prestigious. Prestigious institutions matriculate higher achieving students who tend to graduate at higher levels. Third, the variables tell us just a bit about use. Circulation tells us how often our materials are checked out. Instruction tells us how often students come to the library to learn research. As detailed in Chapter 1, library use has long been used as an indirect indicator of engagement with the library, but the use statistics do not describe the nature of the use.

What do these variables not tell us about the library? They do not reveal anything about the quality of the library. The number of librarians does not say a thing about the worthiness of their interactions with students. The library budget says nothing about how well that money is spent. The number of items circulated does not disclose how students made use of those materials. The number of classes taught cannot communicate what and if students learned and whether or not that instruction was useful to their studies.

It is interesting to note that librarians per student (or conversely students per librarian) is likely the strongest of the traditional input and output measures. This was confirmed by the linear regression analysis as well as the modification indices in the structural equation model. As we cautiously suggested in our earlier research with similar

findings, "it is not the individual input measures such as collections and output measures such as use and services that make a difference. Instead, it is the complex interrelationships between these factors and the professional library staff and the students and faculty that make a difference in student persistence" (Emmons & Wilkinson, 2011, p. 19).

I used these variables for the same reasons that so many other researchers use them: because they are so easily available – and because they matter to decision-makers. Libraries report input and output measures on an annual or biannual basis to the ARL or ACRL and NCES surveys I described in Chapter 1. These input and output measures have been collected for decades and a type of inertia has developed. Though some libraries have heeded the call made by so many librarians and library associations in the past several years to devise new outcome and impact measures, they tend to do so at the local level. This makes sense, as outcome and impact measures are by their nature designed to measure success against student and institutional needs and performance.

The Association of College & Research Libraries (ACRL) realized that this was the case and decided to once again revise its *Standards for Libraries in Higher Education*. Those standards, released in 2004, called for focusing on "documenting the library's contribution to institutional effectiveness and student learning outcomes" (Association of College & Research Libraries, 2004, p. 1). The newly revised *Standards for Libraries in Higher Education*, approved in October of 2011, focus on impact measures and "are designed to guide academic libraries in advancing and sustaining their role as partners in educating students, achieving their institutions' missions, and positioning libraries as leaders in assessment and continuous improvement on their

campuses" (Association of College & Research Libraries, 2011, p. 1). The revised standards continue to take an outcomes-based approach, but do so explicitly in the context of local institutional effectiveness and impact. The *Standards* are a good tool for individual academic libraries as they assess their impact upon their students and their institutions. They are not, however, useful in making comparisons across multiple institutions and as a result they do not serve the needs of researchers conducting comparative research across multiple institutions. Consequently, researchers continue to rely on input and output measures that reveal little about the outcomes or the impact of the academic library. Is there an alternative?

Library Engagement Measures

When I embarked upon this study, I had hoped to use the experimental library engagement measures administered as part of the 2006 National Survey of Student Engagement (2006). In fact, their existence was the reason I targeted that year for data gathering. Unfortunately, only 33 institutions availed themselves of the opportunity to take part in the pilot study. Since the analyses I presented in this paper were conducted at the institutional level, I was left with a sample far too small for structural equation modeling or multiple linear regression. However, I imagined that the data could still be informative, so I examined the descriptive statistics for those items and the estimated correlations from those items with other measures (see Appendix B for a detailed discussion).

I found that the magnitude of the estimated correlations between the library engagement measures and other measures to be much greater than estimated correlations between the more traditional library input and output measures and other variables in my

hypothesized model. This was particularly true for all of the academic performance measures as well as with all of the academic integration measures except for collaborative learning, which was comparable. It is feasible that with stronger estimated correlations, it is more likely that the model I hypothesized and tested with structural equation modeling would have fit.

The stronger correlations between library engagement and academic performance and engagement measures mean that there is a possibility that a national measure of library engagement could be developed for comparison across libraries. To date, however, NSSE has only offered the experimental measure that one year in 2006. That may be about to change. A small group of librarians is working with NSSE and met at the June 2011 and January 2012 American Library Association meetings to begin drafting a new information literacy module that could be added to the regular NSSE survey. I am a part of that group. We are hoping to complete our initial work by the June 2012 American Library Association meeting. If the outcome is successful, researchers and librarians will have a tool that might offer a more authentic means of assessment and the ability to compare across institutions.

NSSE measures

NSSE measures seemed to serve well as indicators for the constructs in my model. The analysis of the estimated correlation matrix showed moderate relationships with each other and with other non-library constructs. Based upon the magnitude of the unstandardized estimated regression coefficient when controlling for all other variables in the multiple regression model and the modification index number in the structural equation model, Bloom's Taxonomy appeared to be a good indicator for academic

performance. Critical thinking, which is a related concept, also served as a moderately strong indicator. It is a little more difficult to determine which measures serve as the best indicators for academic integration. Correlation matrices indicate that the different indicators correlated well across most measures, but that they varied according to measure. Estimated unstandardized coefficients from the multiple regression model on graduation showed only collaborative learning, holding the other variables constant, had a large, positive effect. Relationships with faculty and with other students showed a good relationship with institutional commitment. And though I was worried that I would not find a good measure for intent to persist when I first began investigating data for use in my project, overall experience correlated very well (too well, in fact) with the idea that students would return to the same institution if they could do it all over again.

Pike's Scalelets

I used five of Pike's twelve scalelets in my model. Pike (2006a, 2006b) developed his scalelets for use as a more granular measure of student engagement factors. He deemed that all twelve of his scalelets were reliable. However, in my sample, two of the scalelets as he had constructed them were not reliable. I added one question from NSSE that Pike had used in a different scalelet and removed another to develop a more reliable Active Learning scalelet. I removed two questions from the Collaborative Learning scalelet to make it more reliable – though I worried about the face validity of the two remaining questions. In my sample, Pike's scalelets for Course Challenge, Interactive Learning, and Support for Student Success were all reliable as he originally fashioned them. While Pike devised his scalelets for use as a measurement tool on campuses, they served as solid indicators for academic performance, academic integration, and intent to

persist constructs and will serve other researchers interested in utilizing indicators for student engagement.

Implications

The implications for researchers interested in exploring the relationship between the library and student persistence are clear. At the local level, librarians must continue to assess the impact that their library has upon their college or university. They must collect quantitative and qualitative data and work with institutional researchers to see what difference their library and their librarians have made upon student success.

I plan to conduct research at the local level by exploring the relationship between the academic library and student success at the University of New Mexico where I work as the University Library's Planning & Assessment Officer. I anticipate finding quantitative measures that I can use to conduct a logistic regression to see if engagement with the library leads to success in the university. At the same time, I will use qualitative critical incident methods to interview students and find out how engaging the library has helped them succeed.

As I initiate these and future studies, I am interested in student success in its broadest terms. In this study, I used persistence as a measure of student success, but my interest is in all types of success. I hope to find out what aspects of library services and resources help students succeed in ways they define success. I hope to find out why the librarian makes a difference. I hope to corroborate existing studies that show the library impacts academic performance and integration and to move beyond to find out how the library impacts social engagement. I hope to find out if the library as a place matters to students. At the University of New Mexico, we regularly use an instrument called

LibQual+ to measure customer satisfaction with the library as a provider of services, a supplier of collections, and a proprietor of a place – in our most recent results, we found that undergraduates valued the library as a place and I want to find out why. I hope to investigate the role of place in both student academic and social engagement. I also hope to find out the value that individual programs have upon student success. For example, our library offers the Indigenous Nations Library Program (INLP) to help foster success among Native American students (Aguilar, 2006) and I hope to work with the program's director to see what impact it has upon their success. In the long run, I hope to demonstrate the value of my library and its services, resources, and programs to student success.

The Association of College and Research Libraries has provided help to academic librarians hoping to assess their libraries' impact with its Value of Academic Libraries initiative and with the revised *Standards for Libraries in Higher Education* (Association of College & Research Libraries, 2011). The *Values* report helps librarians identify means of assessing impact and the *Standards* provide a framework that librarians can use at their institutions to demonstrate their value and their contributions to student success.

At the national level, the goal is also clear, but the path is fraught with challenges. Saracevic and Kantor (1997a, 1997b) claimed that it is nearly impossible to show the benefit of the academic library at the institutional level and argued that study should be left at the individual level in the context of the larger institution. I must respectfully disagree. It is difficult, but my own research has shown that it can be done. The goal is to develop and maintain a set of measures and techniques that can be used by researchers to demonstrate the academic library's impact and by administrators to make decisions when

allocating resources. The challenges on the path are many. First, despite calls to begin collecting more meaningful statistics, national library associations and the federal government continue to collect input and output statistics that tell us more about a library's size than its quality. Researchers need to determine which of these input and output measures, if any, serve as indicators of quality. The models described in Chapter 1 such as Urquhart's Library Measurement Model (see figure 23) imply that input and output measures influence outcomes measures, but that was not necessarily true for my study. Researchers need to find specific links.

Figure 23: Urquhart's (2004) Library Measurement Model

More importantly, researchers need to develop new measures of quality. The new measures need to be as simple and straightforward to collect as are input and output measures. The librarians working with NSSE to develop a new set of library engagement indicators are on the right path. At the very least, we should ask that NSSE separate the library out as a service separate from the larger administrative support category so that statistical analysis can be conducted against their tried and true engagement measures. Ideally, we should ask that NSSE incorporate separate questions about library engagement into their survey. But, if history serves, it is likely that NSSE will pilot the indicators in a single study and will adopt few if any of the individual questions into their larger survey. And even if NSSE administrators do add individual library engagement questions to their survey or decide to adopt the information literacy module whole cloth, NSSE remains a proprietary instrument, thereby limiting its wider use in research.

Academic librarians need valid and reliable measures that relate the library to student success. We need instruments that are simple to administer and analyze. We need questions that are routinely collected every year. And we need results that are widely disseminated. In order for this to happen, library associations or the federal government must take leadership.

In the United States, the Association of Research Libraries (ARL) and the Association of College and Research Librarians (ACRL), along with the U.S. Department of Education, are the groups that currently gather statistics and are therefore the most likely organizations to foster change as to which statistics are gathered. Earlier attempts to make changes with new measures have met with limited success due to the challenges of finding and collecting measures that work. But also, in some cases, individual colleges and universities who fare well with the current input and output measures due to their size have resisted change. And also, possibly, bureaucratic inertia has kept the traditional measures in place – especially with no alternate measures readily available.

The ongoing push for accountability in times of financial stress is an opportunity to push through this inertia. Government officials want to know how the monies they spend help bolster the workforce. Accrediting agencies want to know how institutions help their students learn. Campus administrators want to be sure that they are spending their budget wisely in the face of pressures for efficiency and accountability. Librarians and the associations that represent them can step in and help to answer these questions. As a member of the ACRL Board who is actively involved with the Value of Academic Libraries initiative, I intend to use my position to influence the conversation and to push for measures of quality and impact that will answer questions of accountability.

I will once again quote the SPEC Kit on impact measures: “despite the urgency the library community has felt in recent years to justify its value, the responding libraries reported shockingly little work that focuses on investigating whether use of library resources correlate with measures of success for library users” with only 34% of respondents having conducted research on their library’s impact (Koltay & Li, 2010, p. 9). While the survey that accompanied the SPEC Kit did not ask librarians why that might be the case, the obvious answer is that it is difficult to demonstrate value. Associations are perfectly primed to intercede and provide the help academic librarians need and I intend to use my position on the ACRL Board to encourage and facilitate the development of measures that will make it easier to demonstrate value.

Research Questions

Unfortunately, my model did not bring me much closer to answering the question of why the academic library has an impact on student persistence. I was able to corroborate that the relationship demonstrated in other studies does exist. I was able to find some positive relationships between library indicators and measures of student academic performance and student engagement. I was able to confirm that librarians do make a difference. But I was not able to answer the fundamental questions of why and how.

In future research, I plan to continue exploring the relationship between the academic library and student success. As I mentioned earlier, I will use both quantitative and qualitative methods to explore how my own library has helped students succeed. But I remain interested in asking the same questions at the national level. Fortunately, I am currently situated in a position where I can influence the national research agenda. In

addition to serving as an ACRL Board member and a member of the group formulating NSSE library engagement questions, I have been asked to join a formal national conversation designed to shape the research agenda around library values.

My study can contribute to that research agenda, as it raised more questions than it answered. We know that the library has a positive impact on student persistence, but we do not know why or how. The literature on student persistence is vast. Pascarella and Terenzini (1991, 2005) compiled two book length literature reviews in which they cited thousands of items on the influence of college upon students; in each book they devoted an entire chapter to educational attainment, a category that included hundreds of pieces of research on persistence. Astin (1977, 2001) identified "135 college environmental measures and "57 student involvement" measures" (p. xii) that impact student success. Prime among these measures in both reviews is student involvement, which Cabrera, Nora, and Castañeda (1993) termed integration and has now widely become known as engagement. What role does the library play in student engagement? What little is written is more aspirational than empirical. What empirical evidence can we find for the library's influence on student engagement?

Astin (1977, 2001) developed the widely used I-E-O model – written out as Inputs → Environment → Outcome – as a conceptual framework for studying student success. Students bring *inputs* with them to campus and the library is unlikely to be able to influence them. But what *environmental* factors can the library influence to produce positive *outcomes*? What programs, policies, faculties, peers, and educational experiences make a difference in persistence and how can the library assist? What are the mediating factors that the library can shape? What can researchers learn from successful local

outcomes assessment projects? How can local projects be gathered and analyzed and synthesized and generalized to serve as cross institutional studies? How can library associations facilitate this process?

What qualitative evidence can we find for the library's influence on student engagement? What can students tell us about the library's influence upon their success? How does interacting with librarians make them more likely to stay in school? What types of interactions best serve student success? What does quality mean when a student interacts with a library?

Measurement is an issue ripe with possibilities for research. What traditional input and output measures are related to student persistence? What qualities inherent in these measures lead to student persistence? What new measures can we develop? How can we tie library measures to widely accepted influences that lead students to persist such as student engagement and academic performance? How can the library influence areas outside its traditional purview that influence persistence such as social engagement?

Social engagement is a major part of persistence models, yet is little studied in the academic library. What does social engagement look like in a library? Does it make a difference in student success? If so, how can we design libraries to foster social engagement as well as academic engagement? How can we create programs that socially engage students? What role does the library as a place play in student social engagement? How can we demonstrate that social engagement in the library leads to student persistence?

How can administrators use the results of studies to make their case for more resources? How can they operationalize the research findings? If librarians do indeed

make a difference, how many librarians are optimal? Which librarians make a difference? What programs will make the most difference? What type of engagement nurtures students the most?

How can leaders in academic library associations leverage positive results? How can they foster the research that will lead to new measurement models? Which measures should they adopt and use to supplement or replace the more traditional input and output measures they already collect?

The possibilities for research are endless and limited only by the imagination of the researcher.

Conclusion

I opened with a quote by Timothy Dwight claiming that the "library is in a most important sense, the center of the University life" (quoted in Katz, et al., 1989, p. 42). While this once overworked cliché has been expressed about the academic library since time immemorial, it is no longer accepted as a truism. In these times of accountability, tight budgets, and competition, library leaders need to make a strong case that the library matters, that librarians make a difference in the lives of students. My goal when I set out was to make a case to library and campus administrators for the library's role in student success by investigating its impact on persistence. While I was not altogether successful, I would like to think that my study contributed in some small part to the ongoing exploration of the library's impact on student success.

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APPENDIX A:

CODEBOOK

Table A1:
Codebook

Name	*Variable Name*	*Label*
ID	ID	ID = key variable
Library Construct Indicators		
Name	*Variable Name*	*Label*
Librarians	STLIBPRO_coll	Total librarians and other professional staff - collapsed
Expenditures	EXTOT_coll	Total library expenditures - collapsed
Serials expenditures	EXCUSER_coll	Expenditures for Current serial subscriptions (ongoing commitments) - collapsed
Circulation	CRGEN_coll	General circulation transactions - collapsed
Instruction	ATTEND_coll	Total attendance at all presentations - collapsed
Librarians (Log10)	STLIBPRO_coll_Log10	Total librarians and other professional staff - collapsed - transformed with Log10
Expenditures (Log10)	EXTOT_colll_Log10	Total library expenditures - collapsed - transformed with Log10
Circulation (Log10)	CRGEN_coll_Log10	General circulation transactions - collapsed - transformed with Log10
Instruction (Log 10)	ATTEND_coll_Log10	Total attendance at all presentations - collapsed - transformed with Log10
Librarians ratio	LIBRAT_coll	Ratio of library professional staff to FTE students - collapsed
Librarians ratio inverted	LIBRAT_inverse	Ratio of library professional staff to FTE students - collapsed
Expenditures ratio	EXPRAT_coll	Ratio of total library expenditures to FTE students - collapsed
Serials ratio	SUBRAT_coll	Ratio of serial subscriptions to FTE students - collapsed
Circulation ratio	CIRCRAT_coll	Ratio of total circulation to FTE students
Instruction ratio	ATTRAT_coll	Ratio of attendance in library instruction to FTE students - collapsed
Librarians ratio (Log10)	LIBRAT_coll_Log10	Ratio of library professional staff to FTE students - collapsed - transformed with Log10
Librarians ratio inverted (Log10)	LIBRAT_inverse_Log10	Ratio of library professional staff to FTE students - collapsed - transformed with Log10

Expenditures ratio (log10)	EXPRAT_coll_Log10	Ratio of total library expenditures to FTE students - collapsed - transformed with Log10
Circulation ratio (Log10)	CIRCRAT_coll_Log10	Ratio of total circulation to FTE students - collapsed - transformed with Log10
Instruction ratio (Log10)	ATTRAT_coll_Log10	Ratio of attendance in library instruction to FTE students - collapsed - transformed with Log10

Academic Performance Construct Indicators

Name	*Variable Name*	*Label*
Memorized	memorize_Mean	Memorizing facts, ideas, or methods from your courses and readings so you can repeat them in pretty much the same form - Mean
Applied	applying_Mean	Applying theories or concepts to practical problems or in new situations - Mean
Analyzed	analyze_Mean	Analyzing the basic elements of an idea, experience, or theory, such as examining a particular case or situation in depth and considering its components - Mean
Synthesized	synthesz_Mean	Synthesizing and organizing ideas, information, or experiences into new, more complex interpretations and relationships - Mean
Evaluated	evaluate_Mean	Making judgments about the value of information, arguments, or methods, such as examining how others gathered and interpreted data and assessing the soundness of their conclusions - Mean
Bloom	Bloom	Bloom's Taxonomy scale: Calculated as mean of memorize, applying, synthesz, evaluate.
Critical	gnanaly_Mean	Critical thinking: To what extent has your experience at this institution contributed to your knowledge, skills, and personal development in thinking critically and analytically - Mean
Lifelong	gninq_Mean	Lifelong learning: To what extent has your experience at this institution contributed to your knowledge, skills, and personal development in learning effectively on your own - Mean
Grades	grades04_Mean	What have most of your grades been up to now at this institution? - Mean

Academic Integration Construct Indicators		
Name	*Variable Name*	*Label*
Challenge Index (NSSE)	ACa_Mean	NSSE Level of Academic Challenge Index (adjusted) - Mean
Asked questions	clquest_Mean	Asked questions in class or contributed to class discussions - Mean
Made presentation	clpresen_Mean	Made a class presentation - Mean
Service learning	commproj_Mean	Participated in a community-based project (e.g., service learning) as part of a regular course - Mean
Integrated ideas	integrat_Mean	Worked on a paper or project that required integrating ideas or information from various sources - Mean
Active (Pike)	Active_Pike	Pike's Active Learning scalelet: Calculated as mean of asked questions, made presentation
Active (Pike) adjusted	Active2_Pike	Pike's Active Learning scalelet adjusted: Calculated as mean of asked questions, made presentation, wrote a paper
Active and Collaborative Index (NSSE)	ACL_Mean	NSSE Active and Collaborative Learning Index - Mean
Group project in class	classgrp_Mean	Worked with other students on projects during class - Mean
Group project outside class	occgrp_Mean	Worked with classmates outside of class to prepare class assignments - Mean
Tutored	tutor_Mean	Tutored or taught other students (paid or voluntary) - Mean
Discussed ideas	oocideas_Mean	Discussed ideas from your readings or classes with others outside of class (students, family members, co-workers, etc.) - Mean
Collaborate (Pike)	Collabor_Pike	Pike's Collaborative Learning scalelet
Collaborate (Pike) adjusted	Collabor2_Pike	Pike's Collaborative Learning scalelet: Calculated as mean of group project outside of class, tutored
Came unprepared	clunprep_Mean	Come to class without completing readings or assignments - Mean
Worked hard	workhard_Mean	Worked harder than you thought you could to meet an instructor's standards or expectations - Mean
Exams challenged	exams_Mean	Examinations during the current school year challenged you to do your best work - Mean

Hours studying	acadpr01_Mean	About how many hours do you spend in a typical 7-day week preparing for class (studying, reading, writing, doing homework or lab work, analyzing data, rehearsing, and other academic activities) - Mean
Institutional emphasis on studying	envschol_Mean	To what extent does your institution emphasize spending significant amounts of time studying and on academic work - Mean
Challenge (Pike)	Challeng_Pike	Pike's Course Challenge scalelet
Challenge (Pike) adjusted	Challeng2_Pike	Pike's Course Challenge scalelet adjusted: Calculated as mean of worked hard, exams challenged, institutional emphasis on studying
Discussed grades	facgrade_Mean	Discussed grades or assignments with an instructor - Mean
Discussed ideas with faculty	facideas_Mean	Discussed ideas from your readings or classes with faculty members outside of class -
Received feedback	facfeed_Mean	Received prompt written or oral feedback from faculty on your academic performance - Mean

Institutional Support Construct Indicators

Name	*Variable Name*	*Label*
Interaction (Pike)	Interact_Pike	Pike's Course Interaction scalelet
Students	envstu_Mean	The quality of your relationships with other students at your institution - Mean
Faculty	envfac_Mean	The quality of your relationships with faculty members at your institution - Mean
Administration	envadm_Mean	The quality of your relationships with administrative personnel and offices at your institution - Mean
Support	envsuprt_Mean	To what extent does your institution emphasize providing the support you need to help you succeed academically - Mean
Institutional work and family support	envnacad_Mean	To what extent does your institution emphasize helping you cope with your non-academic responsibilities (work, family, etc.) - Mean
Institutional social support	envsocal_Mean	To what extent does your institution emphasize providing the support you need to thrive socially - Mean

Support (Pike)	Support_Pike	Pike's Support for Student Success scalelet
Supportive Campus Environment Index (NSSE)	SCE_Mean	NSSE Supportive Campus Environment Index - Mean
Student-Faculty Interaction Index (NSSE)	SFI_Mean	NSSE Student-Faculty Interaction Index - Mean

Intent to Persist Construct Indicators

Name	*Variable Name*	*Label*
Experience	entirexp_Mean	How would you evaluate your entire educational experience at this institution? - Mean
Return	samecoll_Mean	If you could start over again, would you go to the same institution you are now attending? - Mean
Satisfaction	satisfaction	Satisfaction: calculated as mean of experience and return.

Persistence Construct Indicators

Name	*Variable Name*	*Label*
Retention 2006	RET2006_coll	Retention 2006: Full-time retention rate (EF2006D) – collapsed (ALS)
Retention 2007	RET2007_coll	Retention 2007: Full-time retention rate (EF2007D) – collapsed (ALS)
Graduation 2006	GRAD2006_coll	Graduation 2006: Graduation rate total cohort (DRVGR2006) – collapsed (ALS)
Graduation 2007	GRAD2007_coll	Graduation 2007: Graduation rate total cohort (DRVGR2007) – collapsed (ALS)

APPENDIX B:

LIBRARY ENGAGEMENT

Library engagement measures consist of an experimental questionnaire that NSSE included in their 2006 administration called the *Information Literacy Test* (ILT) (Gratch-Lindauer, 2008). I had originally planned to fit a second model using the ILT questions as indicators for the library construct, but only 33 institutions participated, a sample size far too small for structural equation modeling or a multiple linear regression analysis. Instead, I took a cautious look at correlations to see if they could tell me anything about the library's impact upon academic performance and academic integration. The indicators for the library engagement construct included:

1. In your experience at your institution during the current school year, about how often have you done each of the following? [Response options included very often, often, sometimes, and never.]
    A. Asked a librarian for help (in person, e-mail, chat, etc.)?
    B. Went to a campus library to do academic research?
    C. Used your institution's Web-based library resources in completing class assignments?
2. Which of the following have you done or do you plan to do before you graduate from your institution? [Response options included done, plan to do, do not plan to do, and have not decided.]
    A. Participated in an instructional session led by a librarian or other library staff member?
    B. Participated in an online library tutorial?

3. To what extent does your institution emphasize each of the following? [Response options included very much, quite a bit, some, and very little.]
    A. Developing critical, analytical abilities?
    B. Developing the ability to obtain and effectively use information for problem solving?
    C. Developing the ability to evaluate the quality of information available from various media sources (TV, radio, newspapers, magazines, etc.)?
4. To what extent has your experience at this institution contributed to your knowledge, skills, and personal development in the following areas? [Response options included very much, quite a bit, some, and very little.]
    A. Evaluating the quality of information?
    B. Understanding how to ethically use information in academic work (proper citation use, not plagiarizing, etc.)?

Library engagement measures

Library engagement measured how students engage the library by visiting the library, asking questions of a librarian, and using library web resources. Library engagement also asked students about issues of critical thinking, problem solving, and the ethical use of information resources. Table 50 presents the descriptive statistics for these items.

Table B1:
Descriptive Statistics for Library Engagement

	N	Mean	SD	Minimum	Maximum
Asked a librarian	30	2.03	.433	1.64	4.00
Visited library	30	2.61	.373	2.21	4.00
Used library web resources	29	2.72	.305	2.00	3.38
Critical thinking and library	30	3.15	.196	2.80	3.67
Problem solving and library	30	3.08	.266	2.00	3.53
Media literacy	30	2.85	.241	2.00	3.30
Evaluate and library	30	2.97	.147	2.64	3.32
Ethical information use	30	3.16	.299	2.00	3.65
Valid N (listwise)	29				

The NSSE experimental information literacy test asked students, on a scale of 1= Never, 2= Sometimes, 3= Often, 4= Very Often, how often they did each of the following:

Asked a librarian for help (in person, e-mail, chat, etc.). On average, students *sometimes* (2.03) asked a librarian for help, with a minimum approaching *sometimes* (1.64) and a maximum of *very often* (4.00).

Gone to a campus library to do research for a course assignment. On average, students went to the library for research somewhat closer to often than sometimes (2.61). The minimum was below *sometimes* (2.21) while the maximum was *very often* (4.00).

Used your institution's Web-based library resources when completing class assignments. On average, students used the library's web-based resources approaching *often* (2.72). The minimum was *sometimes* (2.00) and the maximum a bit more than *often* (3.38).

The NSSE experimental information literacy test asked students, on a scale of 1= Very little, 2= Some, 3= Quite a bit, 4= Very much, how often they did each of the following:

Developing critical thinking and analytical abilities. Note that this question is virtually identical to a question already on the NSSE survey. For the sample of 33

libraries, students on average claimed that their institutions emphasized critical thinking *quite a bit* (3.15). The minimum approached *quite a bit* (2.80) and the maximum fell slightly closer to *very much* than to *quite a bit* (3.67).

Developing the ability to obtain and effectively use information for problem-solving.

On average, students felt that their institutions emphasized problem solving *quite a bit* (3.08). The minimum was *some* (2.00) and the maximum fell halfway between *very much* than to *quite a bit* (3.53).

Developing the ability to evaluate the quality of information available from various media sources (TV, radio, newspapers, magazines, etc.). On average, students felt that their institutions emphasized media literacy a bit less than *quite a bit* (2.85). The minimum was *some* (2.00) and the maximum was just over *quite a bit* (3.30).

Evaluating the quality of information. On average, students were asked to evaluate the quality of information *quite a bit* (2.97). The minimum and the maximum were just under (2.64) and just over (3.32) *quite a bit*.

Ethical use of information sources in academic work (proper citation use, not plagiarizing, etc.). On average, students were asked to use information ethically quite a bit (3.16). Minimum was some (2.00) and maximum approached very much (3.65).

Summary of Library Engagement Indicators. Overall, students were most likely to engage in critical thinking and problem solving, and to use information ethically. They were least likely to ask a librarian for help or to visit a library.

An analysis of the estimated correlation matrix revealed substantially higher correlations between the library engagement measures and all of the academic

performance measures as well as with all of the academic integration measures except for collaborative learning, which is comparable.

Table B2:

Estimated Correlation Matrix with Library Engagement Variables (N =33)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Asked librarian	1																						
2. Visited library	.865**	1																					
3. Web resources	.446*	.716**	1																				
4. Critical library	.124	.312	.492**	1																			
5. Problem solving	-.488**	-.318	.358	.702**	1																		
6. Media Literacy	-.331	-.179	.478**	.614**	.863**	1																	
7. Evaluate info	.338	.457*	.502**	.816**	.547**	.594**	1																
8. Ethical info	-.450*	-.288	.496**	.554**	.887**	.808**	.550**	1															
9. Bloom	.374*	.504**	.413*	.810**	.481**	.479**	.855**	.428*	1														
10. Critical	.506**	.620**	.460*	.831**	.267	.248	.794**	.196	.825**	1													
11. Lifelong	.519**	.589**	.377*	.712**	.212	.229	.775**	.161	.682**	.749**	1												
12. Active	.647**	.558**	.173	.395*	.035	.217	.664**	.082	.614**	.442**	.449**	1											
13. Collaborative	-.178	.078	.389*	.480**	.513**	.365*	.377*	.421*	.345**	.391**	.255**	.062	1										
14. Challenge	.598**	.643**	.349	.693**	.237	.259	.778**	.182	.589**	.674**	.596**	.347**	.295**	1									
15. Interaction	.400*	.423*	.291	.483**	.299	.354	.602**	.390*	.684**	.617**	.630**	.673**	.313**	.454**	1								
16. Students	.260	.321	.152	.561**	.327	.287	.688**	.304	.173**	.322**	.371**	.235**	.337**	.399**	.266**	1							
17. Faculty	.353	.368*	.142	.438*	.258	.338	.645**	.313	.494**	.576**	.513**	.550**	.195**	.403**	.742**	.548**	1						
18. Administration	.461*	.361*	.078	.352	.113	.255	.557**	.056	.212**	.357**	.375**	.353**	.115*	.374**	.397**	.605**	.690**	1					
19. Support	.383*	.485**	.453*	.645**	.336	.493**	.738**	.290	.367**	.506**	.502**	.268**	.392**	.390**	.529**	.642**	.728**	.642**	1				
20. Experience	.124	.316	.339	.832**	.507**	.457*	.776**	.400*	.580**	.751**	.596**	.244**	.367**	.543**	.481**	.506**	.686**	.525**	.685**	1			
21. Return	.167	.289	.178	.651**	.319	.291	.622**	.168	.352**	.547**	.507**	.098*	.232**	.347**	.253**	.499**	.499**	.496**	.542**	.854**	1		
22. Retention	-.256	.023	.359	.506**	.419*	.301	.286	.299	.378**	.352**	.181**	-.109*	.307**	.189**	.025	.034	.012	-.132**	.170**	.471**	.357**	1	
23. Graduation	-.166	.069	.343	.430*	.309	.205	.322	.284	.434**	.426**	.229**	.024	.383**	.225**	.178**	.152**	.209**	-.024	.304**	.557**	.367**	.821**	1

** Correlation is significant at the 0.01 level.

APPENDIX C:

INFLUENTIAL CASES IN MODEL 6A

I tested Model 6A for any unusual or influential cases. I calculated PRESS residuals, HAT statistics, Cook's Distance, and the covariance ratio to find cases that fall well outside the model. I examined the scatterplots of unstandardized predicted value against standardized residual (see figure C1) and case number against studentized deleted residual, centered leverage value, Cook's Distance, and covariance ratio (see figure C2).

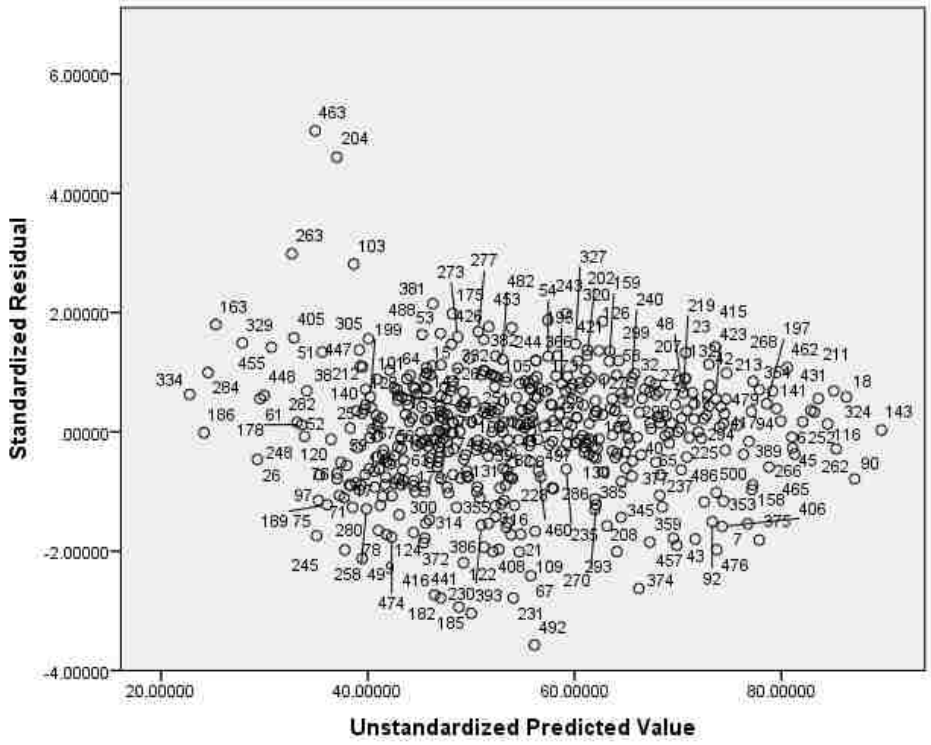

Figure C1: Scatterplot of unstandardized predicted value against standardized residual indicating that cases 204 and 463 may be influential

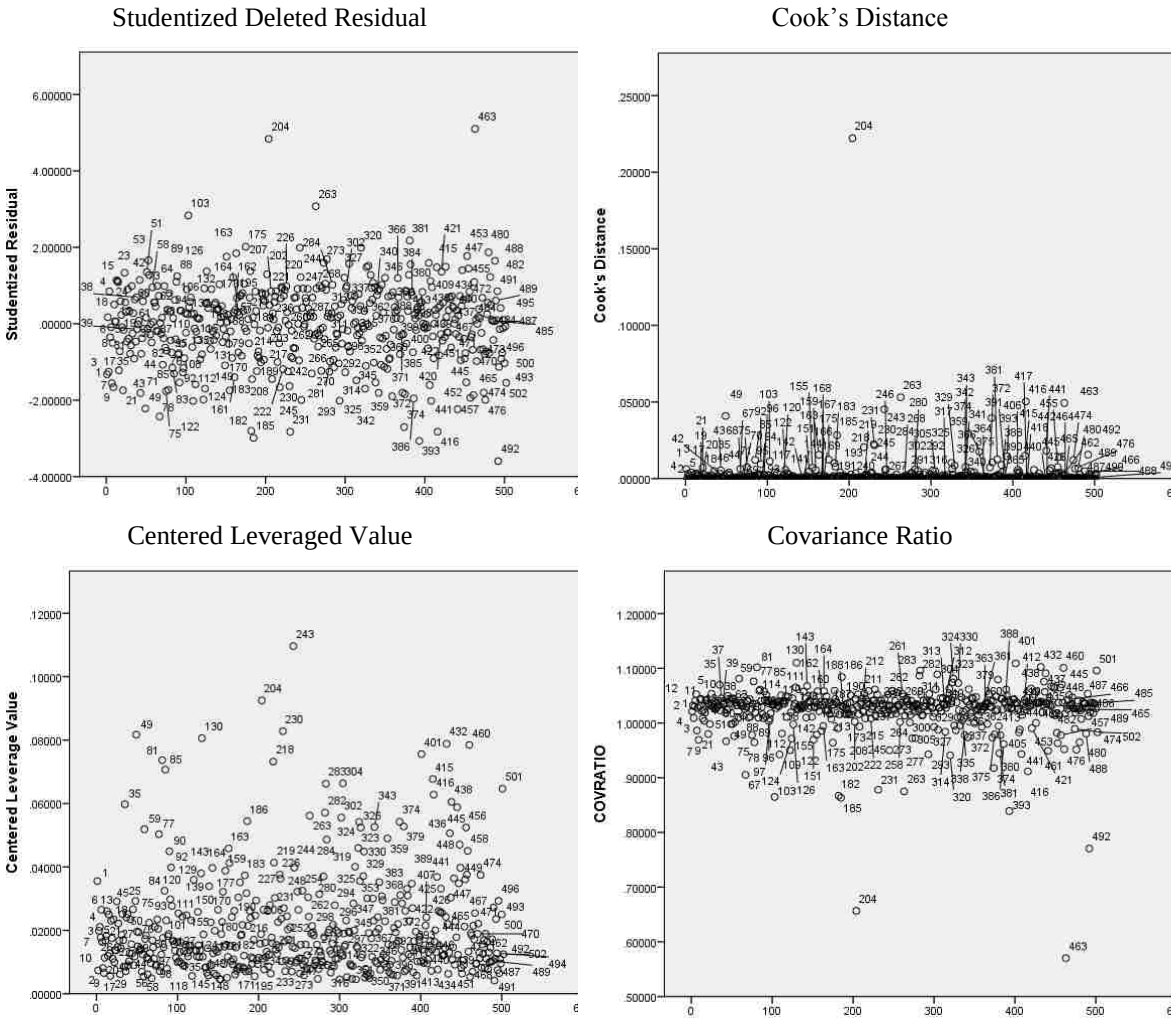

Figure C2: Scatterplots of case number against studentized deleted residual, centered leverage value, Cook's Distance, and covariance ratio indicating that cases 204 and 463 and 492 may be influential

I found three cases that were extreme on Y with case 204 showing extreme in every scatterplot. I refit each model by excluding each institution in turn and by combining case 204 with cases 463 and 492 both individually and together. I found that the most significant change in effects on GRAD occurred when two institutions were excluded. See Table C1.

Table C1:
A comparison of models fitted before and after the removal of atypical data points using a series of fitted multiple regression models in which graduation is predicted by Librarians, Expenditures, Bloom, Critical, Lifelong, Collaborative, Interactive, Administration, Support, and Experience

	Model						
Cases removed	6A None	6A1 204	6A2 463	6A3 492	6A4 204 463	6A5 204 492	6A6 204 463 492
(Constant)	-112.897	-120.527	-116.145	-113.783	-123.759	-121.342	-121.342
Librarians	6.760	4.993	6.881	6.723	5.117	4.970	4.970
Expenditures	6.629	5.093	6.683	6.413	5.149	4.892	4.892
Bloom	58.582	62.121	59.708	58.845	63.240	62.352	62.352
Critical	-26.294	-27.884	-24.775	-27.436	-26.364	-28.997	-28.997
Lifelong	-20.126	-20.018	-22.173	-19.577	-22.062	-19.477	-19.477
Collaborative	15.215	15.539	14.498	15.121	14.823	15.444	15.444
Interactive	-25.678	-25.701	-27.100	-25.703	-27.122	-25.726	-25.726
Administration	-15.097	-16.466	-14.720	-15.146	-16.088	-16.504	-16.504
Support	11.630	9.809	12.018	12.857	10.200	11.033	11.033
Experience	64.456	68.022	65.486	64.528	69.046	68.066	68.066
R^2	.545	.563	.565	.552	.583	.570	.570

Model 6A4, removing cases 204 and 463, demonstrates the largest effect (R^2 = .583). For the sake of simplicity and continuity, I named this model 6B in the body of the study.