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Improving learning center usage verification processes using Six Sigma

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IMPROVING LEARNING CENTER USAGE VERIFICATION PROCESSES USING SIX SIGMA

An Abstract of a Dissertation

Submitted

in Partial Fulfillment

of the Requirements for the Degree

Doctor of Industrial Technology

Approved:

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ABSTRACT

The Academic Learning Center at the University of Northern Iowa provides tutoring and advising services to enrolled students at the university. As Iowa legislatures consider performance based funding, having accurate and timely student usage data is imperative for the Academic Learning Center as the data is used in making funding decisions. The purpose of this research is to improve the student usage verification process and increase the accuracy of data collected by a math and science tutoring center located in the Academic Learning Center. An *Access* database was designed to record and track the math and science tutoring services provided and verify the usage data maintained by the *AccuTrack* system. The Six Sigma DMAIC methodology was used to improve the verification process and the DMADV method was applied when testing the reliability of the database. The Six Sigma DMAIC process improvement methodology improved the efficiency of the learning center's *AccuTrack* verification process. The DMADV methodology is an effective tool for testing the reliability of the new database in verifying the center's usage data. The cycle time for completing the verification process improved by 63% from an average of 44 days to 16 days. Before the process, the number of errors per report ranged between 25 and 111 with an average of 60 errors per report. After the process was improved, errors per report ranged between 0 and 32 with the average number of errors per report being 8. Applying the Six Sigma techniques can refine existing processes and increase the efficiency of a learning center. Accurate usage data assist in acquiring funding and validating request for increased staffing, expanding services, and evaluating the effectiveness of learning centers. The Six Sigma process improvement techniques have not been applied in a tutoring or learning center. The research validates using the Six Sigma DMADV and DMAIC methodologies in these settings.

Key words: Academic services, education, Six Sigma, learning center, tutoring center, accreditation, process improvement, quality

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DEDICATION

This dissertation is dedicated to my parents who have always supported me in all my educational aspirations.

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Thank you, Dr. Zhang, for seeing me through this process until the end and for your mentorship. Dr. Kashef and Dr. VarzaVand, you can retire now. Thank you both for supporting me and for your invaluable and practical counsel. Dr. Kirmani, thank you for every resource you provided to help in the data analysis and for always asking how I was doing.

Dr. Vinton, thank you for being my one-woman cheerleading squad. I treasure every email and encouraging word that came at the appointed time. Dr. Cooley, you are a champion, and thank you for venturing into unchartered territory with me. I admire your tenacity.

To my intercessors, friends, and family who are too numerous to name. Thank you for praying me through, for having faith when I did not, for speaking life and hope into me, and for making sure I ate properly. All the little things you did made this journey much easier.

To my Savior, Jesus, thank you for your faithfulness and completing the work you started in me.

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INTRODUCTION

The Academic Learning Center at the University of Northern Iowa is a relatively new department. Its mission is to “inspire, challenge and empower students to achieve academic success” (Academic Learning Center [ALC], 2016). There are six unique units that comprise the Academic Learning Center (ALC)—Academic Achievement and Retention Services (AARS), the College Reading and Learning Center (CRLC), Testing Services, Math and Science Services (MASS), Student Support Services (SSS), and the Writing Center (WC). Each unit has a coordinator/director charged with oversight to ensure compliance with university standards, fulfillment of the Academic Learning Center mission, development and implementation of programs to meet the needs of UNI students, and assisting the university in reaching its mission of providing “transformative learning experiences that inspire students to embrace challenge, engage in critical inquiry and creative thought, and contribute to society” (Office of the Provost and Executive Vice President for Academic Affairs, 2010). The six units are categorized based on the type of services they offer: advising services, tutoring services, or testing services (See Figure 1). Academic Achievement and Retention Services and Student Support Services are the two advising programs. They offer students holistic advising and assist students with academic and long-term planning and financial literacy. Students Support Services is federally funded and must adhere to the US Department of Education guidelines as well as those of the university. Academic Achievement and Retention Services is funded by the state of Iowa. Testing services administers standardized tests such as the GRE, LSAT, ACT, TOEFL and CLEP. The College Reading and Learning Center, Writing Center, and Math and Science Services offer tutoring services such as writing assistance, academic coaching, study strategies, and content-based tutoring. Testing Services serves both UNI students and members of the general public. However, the services offered by Academic Achievement and Retention Services (AARS), the College Reading and Learning Center (CRLC), Math and Science Services (MASS), Student Support Services (SSS), and the Writing Center are available only to currently-enrolled UNI students.

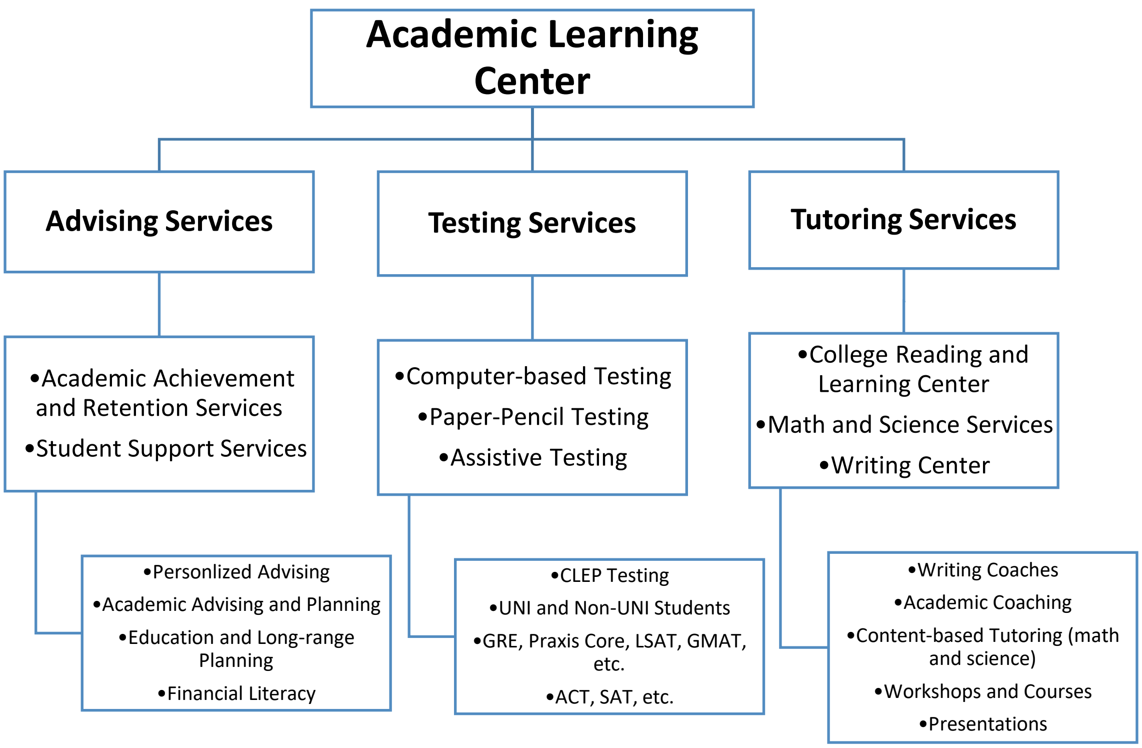

Figure 1. Academic Learning Center structure and programs

The six units have an intricate dependency that allows them to operate symbiotically yet independently. This symbiotic relationship helps to ensure students utilize all the resources available through the Academic Learning Center to help them be academically successful. For example, students in Student Support Services who take the mathematics section of the Praxis Core through Testing Services and do not get the scores desired may be referred by their advisor to Math and Science Services for mathematics tutoring. Students who do not meet the guidelines to participate in Student Support Services are referred to Academic Achievement and Retention Services. Likewise, students utilizing the tutoring services may be referred to the advising services and vice versa. This symbiosis is depicted in Figure 2.

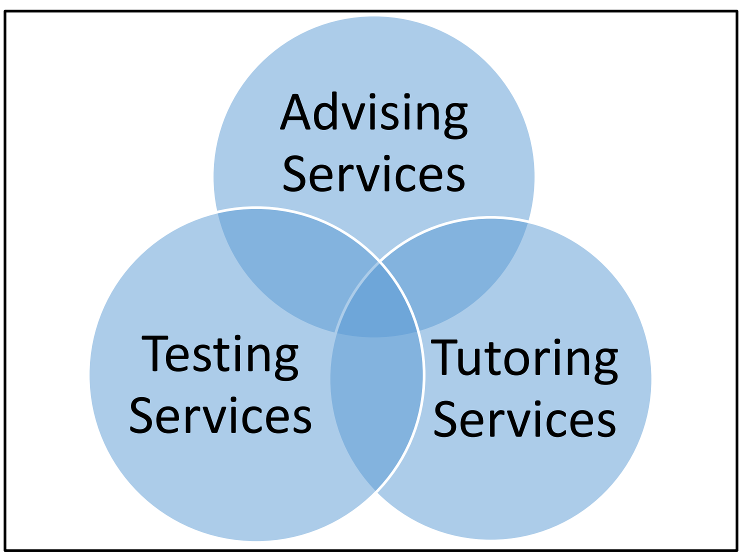

Figure 2. Symbiotic representation of Academic Learning Center services

Despite the symbiotic relationship, there are differences between the six units. It is the unique combinations of similarities and differences that have made it difficult to find an assessment tool that would comprehensively evaluate the Center or a process improvement instrument to test the efficiency of the processes used by the Center as well as its six units.

Statement of Need and Problem

In Fall 2009, the Academic Learning Center began a five year assessment process using the Council for the Advancement of Standards (CAS) in Higher Education assessment tools for advising programs and learning centers. CAS helped the center develop its structure, evaluate whether or not current policies and procedures align with best practices for learning centers, and provides a tool for to identify what is missing in terms of vision, mission, and services offered through the Center. The units of the Academic Learning Center provide services and programs that meet certain aspects of the CAS Standards. However, CAS does not provide a tool for evaluating the effectiveness of specific services offered and does not offer a tested methodology for making improvements in how these services are provided to students. It is essential that the learning center answers these questions as it seeks to expand services with limited financial resources.

In 2012, the Academic Learning Center Assessment Team developed a survey to measure impact and satisfaction to evaluate overall effectiveness of the services provided. The survey was administered to a subset of more than 1600 students who used the

Academic Learning Center and provided a valid e-mail address. The survey was designed to measure the impact of programs and services on students' learning and the students' level of satisfaction with the services they used. The survey was administered in Fall of 2012, 2013, and 2014 and assessed the six units and the ALC overall. The survey provided the six coordinators and the ALC director valuable feedback on the quality of services offered. Results brought to the coordinators' attention students' frustration with the Center's sign-in/sign-out process and how much time the process took away from time allocated for students to receive direct academic support from staff. Furthermore, coordinators learned how much time student workers and permanent staff spent fixing mistakes made by students during the sign-in-sign-out process.

In addition to the Academic Learning Center surveys, in 2012, two marketing research teams administered surveys and held focus groups with UNI students who used the center. Both research groups wanted to find ways the Academic Learning Center could attract more students. One group's secondary objective was to find the best time during students' academic career for them to learn about the Academic Learning Center (Lilly, Gilbert, Blanche, & O'Hern 2012; Schmitt, Kappmeyer, Hargett, & Geistkemper, 2012). The other group's secondary objective was to ascertain students' perceptions of the center (Lilly et al., 2012; Schmitt et al. 2012). The research groups found the 8:00 a.m. to 5:00 p.m. hours of operation were restrictive and did not coincide with the times students studied and were in need of academic support. Students surveyed and interviewed in both research groups expressed the need for the center to expand its services into the residence halls and other academic buildings. Expanding the center to satellite locations requires increasing the number of staff and determining which service offerings would work best in a “residence hall” environment.

On average, the Academic Learning Center serves over 3000 diverse students per year including students who are first generation, low income, transfers, underprepared, domestic, and international. Services offered through the Center are delivered to students via workshops, short courses, presentations, appointments, and by walking in. A satellite of the learning center is located in the campus library and offers walk-in services on Sundays. All users are required to sign in and out to help the Center ascertain how many students utilize its services, the peak hours of usage, and the demand for different services.

The tracking system used to collect the usage data is *AccuTrack*. Each month, the *AccuTrack* usage data for the six units and the computer lab are verified and approved by the respective coordinators. The verification process is necessary since the monthly *AccuTrack* data is used to compile the six units’ Annual Progress Reports that are provided to the Center’s director. The director uses the six progress reports to compile the Academic Learning Center’s Annual Progress Report. The Center director in turn shares the Annual Progress Report with the Associate Provost, partners and supporters, and other university constituents who use the data to make funding decisions that can positively or negatively impact the learning center. Thus it is imperative that the *AccuTrack* usage data is verified and corrected each month as the volume of student usage and quality of services offered directly impact the sustainability of the Center. As the university experiences continuous reduction in state allocations, the usage reports of the Academic Learning Center will play a pivotal role in verifying its utility and effectiveness to the university and its students. Moreover, the support services provided through the Center are crucial evidence for the university to address core components of criterions three, four, and five of the Higher Learning Commissions core components for continued accreditation:

- Criterion 3.C.6: Staff members providing student support services, such as tutoring, financial aid advising, academic advising, and co-curricular activities, are appropriately qualified, trained, and supported in their professional development.
- Criterion 4.C: The institution demonstrates a commitment to educational improvement through ongoing attention to retention, persistence, and completion rates in its degree and certificate programs;
- Criterion 5.D.2: The institution learns from its operational experience and applies that learning to improve its institutional effectiveness, capabilities, and sustainability, overall and in its component parts. (Higher Learning Commission [HLC] Resource Guide, 2015, p. 9-11).

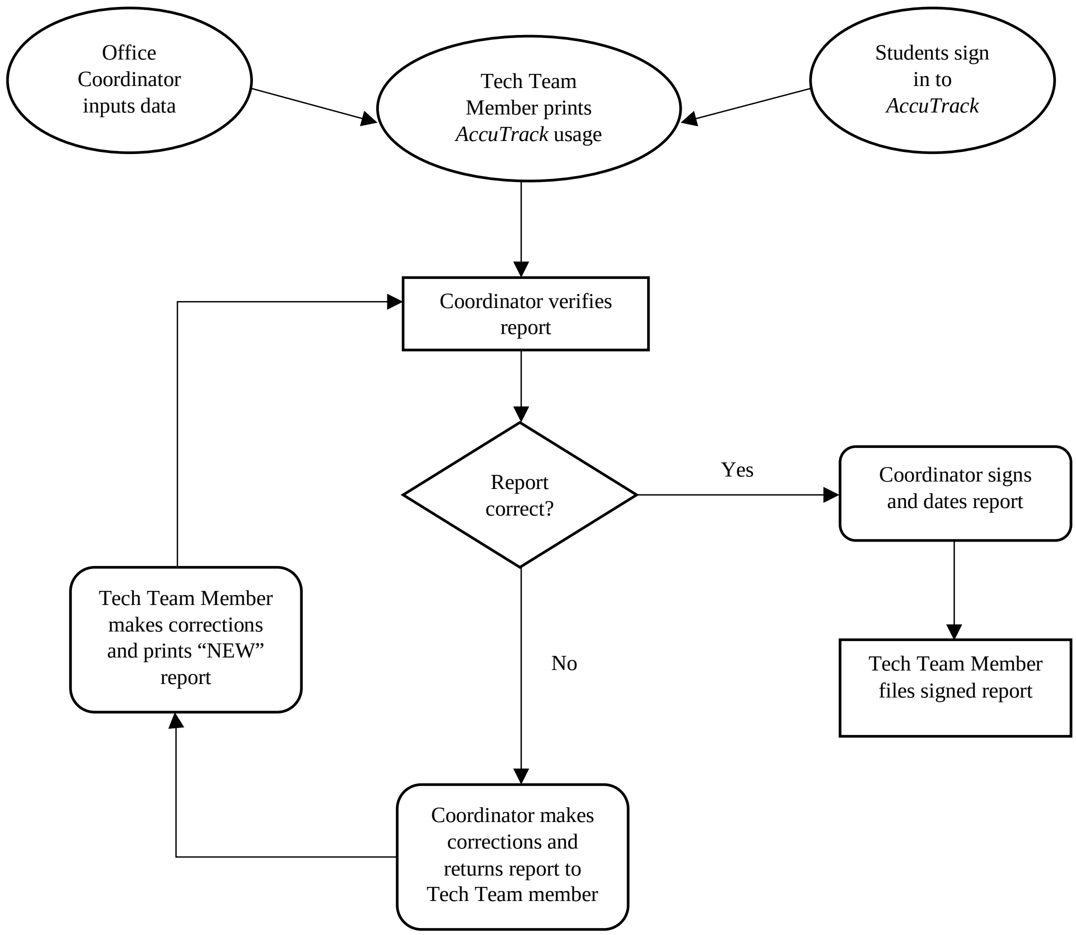

Figure 3. Academic Learning Center *AccuTrack* correction-verification process

The current process for correcting and verifying the *AccuTrack* monthly usage report begins when a Tech Team member prints each unit's report and provides it to the respective coordinator (see Figure 3). The coordinator then checks the report for errors, makes corrections, and returns the report to the Tech Team member to make the needed corrections. These corrections include but are not limited to inputting missing students, deleting student records, and making general corrections to dates, entry and exit times, and program used. Once the Tech Team member makes corrections an updated report is printed and each coordinator verifies that the "corrected" report is indeed correct. This cycle continues until the coordinator receives a report from the Tech Team member that is error free and reflects the correct usage data for the specific unit each month. The current correction-verification process, however, is time consuming, error- prone, and disjointed, and excludes pertinent individuals from the process. It is the researcher's belief that the *AccuTrack* correction-verification process can be improved using Six Sigma methodologies and tools.

Six Sigma is a philosophy and problem solving methodology that takes a "holistic view of reliability and quality" (Summers, 2009, p. 460). Developed by Bill Smith, a reliability engineer for Motorola, the goal in using the Six Sigma tools and methodologies is to improve reliability and quality by reducing the amount of variability in a process. There are two methodologies associated with Six Sigma: DMAIC-Define, Measure, Analyze, Improve, Control and DMADV-Define, Measure, Analyze, Design, and Verify. The DMAIC methodology is used to evaluate and improve an existing process that is not working effectively, and the DMADV methodology is used to develop and evaluate the effectiveness of a new process. Both processes are outlined in Table 1.

Table 1. *Comparison of six sigma DMAIC and DMADV methodologies*

DMAIC Methodology		DMADV Methodology	
Define	Establishes what the problem is; identifies the customer that is being impacted; and the members of the Six Sigma project team.	**D**efine	Define the goal of the design activity. Answers the questions what is being designed and why?
Measure	Process steps are identified along with their corresponding inputs and outputs.	**M**easure	Identifies critical to quality measurements to the customer and set project goals.
Analyze	The root cause of the problem identified along with the critical to quality (CTQ) measures that drive performance.	**A**nalyze	Analyze the options available to meet the goals and determines the performance of these designs.
Improve	Potential solutions are identified and CTQ measures are used to establish process capabilities.	**D**esign	Design the new product or develop the new process.
Control	Processes are controlled and measured; standard operating procedures are developed and disseminated.	**V**erify	Verify the product's design or the new process capability. Benchmark measurements are established.

Based on the current correction-verification process and the Academic Learning Center survey results, the researcher will launch a series of projects using Six Sigma's DMADV and DMAIC methodologies. Four areas of improvement are identified for this Six Sigma project: inconsistencies related to how data are inputted into the *AccuTrack* database system; variability in obtaining the monthly usage reports; delays in completing the correction-verification process; and length of the sign-in-sign-out process. Keeping in line with the philosophy of Six Sigma and the areas of improvement, the project has four main goals:

1. Reduce the number of errors made by students during the sign-in-sign-out process;
2. Increase the accuracy of the student usage data for Math and Science Services (MASS);
3. Reduce the number of documents used to correct and verify the monthly *AccuTrack* usage report for Math and Science Services (MASS); and
4. Reduce the cycle time for verifying the monthly *AccuTrack* usage reports for Math and Science Services (MASS) from one month to 1.5 weeks (11 business days).

Significance of the Study

There are several reasons why this study is important. At the University of Northern Iowa, enrollment among undergraduate first generation students, or students whose parents' highest educational attainment is a high school diploma, has remained steady despite a decline in the University's enrollment (See Figure 4). The university discovered an error in the first generation data for 2013-2014; hence, it is not reported in Figure 4. Nationally, college enrollment amongst ethnic groups with a high percentage of first generation college age students has been increasing (National Center for Education Statistics [NCES], n.d.).

Two National Center for Education Statistics publications, *First-Generation Students: Undergraduates Whose Parents Never enrolled in Postsecondary Education* (1998) and *First-Generation Students in Postsecondary Education: A Look at Their College Transcripts* (2005), reported that:

- 40 percent of first-generation students took remedial mathematics courses compared to 16% of non-first generation students (Chen & Carroll, 2005, p. v);
- First-generation students lagged behind their peers in credit accumulation. This lag was attributed to higher rates of late starts, disrupted enrollment, part-time attendance and leaving without a degree (Chen & Carroll, 2005, p. v);
- “First-generation students persisted in postsecondary education and attained credentials at lower rates than their non-first-generation counterparts” (Nunez, Cuccarro-Alamin, & Carroll, 1998, p. iii).
- The First-generation students had lower first-year undergraduate grade point averages (2.5 versus 2.8) compared to students whose parents were college graduates (Chen & Carroll, 2005, p. vii).

The 2005 report also highlighted that first-generation students were in need of remediation their first year of college and were more likely to withdraw from and repeat courses (Chen & Carroll, 2005, p. vii).

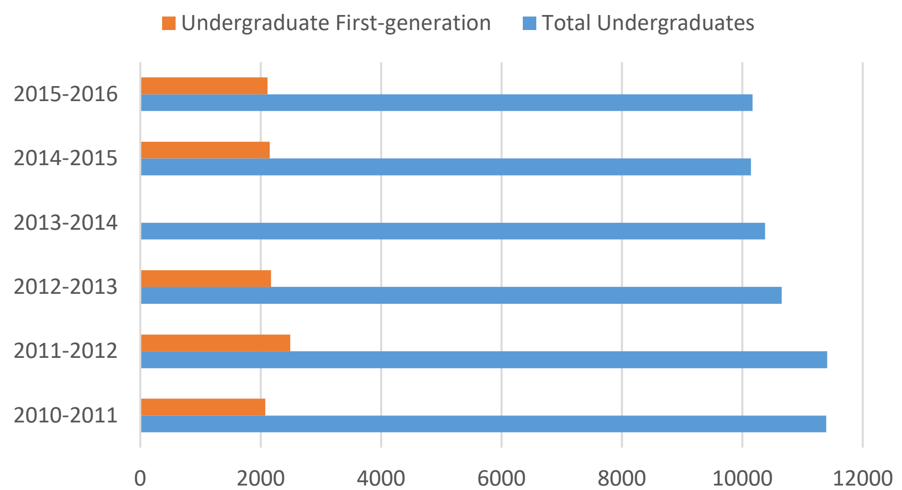

Figure 4. UNI first generation undergraduate enrollment

Many learning centers are comprised of multiple units that provide valuable and necessary services to students, including those who are first generation. As the enrollment trend amongst first generation students continues to increase, the number of first generation students enrolled in post-secondary institutions will rise, and the demand for academic support services will increase. As a result, learning centers will need to evaluate whether their current academic support services, processes, and organizational structures are adequate enough to meet the needs of students entering their respective universities. These centers will also need to determine whether or not the academic support provided to students is being delivered in the most efficient and most cost effective ways. Hence, it will be important to verify whether or not the Six Sigma DMAIC method can be successfully used in a learning center to systematically evaluate the effectiveness of current processes and procedures and help identify where in the learning center procedural and process improvements should be made. If the DMADV methodology can be validated in the learning center setting, it will provide a proven technique that can help learning centers test new processes and evaluate their effectiveness before implementing untested and potentially ineffective processes that consumes valuable time staff would spend providing academic support to students.

Reducing the amount of errors and the length of time needed to verify the data, would cause the monthly usage data to be available to the Academic Learning Center director earlier and will assist in making budgetary decisions, making staffing requests to the Provost, and help validate requests to expand services to better meet students' needs. Reducing the time each coordinator spends completing the report would give coordinators more time to spend directly assisting students and develop programming to meet the needs of special populations such as students with disabilities, underprepared, and first generation students.

The premise is that by developing a systematic process that reduces the number of steps it takes to correct and verify the Math and Science Services monthly *AccuTrack* usage report, the amount of time the MASS coordinator and Tech Team members spend correcting the reports will be reduced. The new process can be shared with the other learning center coordinators to help reduce the number of steps and time spent completing their monthly usage reports and improve the efficiency of all the Academic Learning Center services. As a result, staff are able to work with more students and have more time to provide academic support to students and to develop the needed program and services to meet students' needs.

Definition of Terms

This section elaborates on terminology used throughout the paper that are specific to the areas of education, statistical quality control, total quality management, continuous improvement, and process improvement. Abbreviations unique to these fields are also included.

Academic Achievement and Retention Services (AARS) - one of two advising units in the Academic Learning Center.

Academic Quality Improvement Program (AQIP) - is one of several pathways leading to reaffirmation of accreditation with the Higher Learning Commission (HLC, 2015).

AccuTrack - an academic center management software developed by *Engineerica* (Engineerica Systems Inc, 2016).

Appreciative Inquiry (AI) - "a coordinated approach to organizational change that utilizes reflection, introspection, and collaboration to leverage collective strengths" (Fifolt & Lander, 2013, p. 19).

Balanced scoreboard – "Performance/strategic management system which utilizes four measurement perspectives: financial; customer; internal process; and learning and growth" (Becket & Brooks, 2008, p. 44).

CCNE - Commission on Collegiate Nursing Education

College *Reading and Learning Center (CRLC)* - one of the three tutoring units of the Academic Learning Center that focuses on strategies for effective learning and improving academic skills.

Continuous improvement - philosophy focused on improving processes to enable companies to give customers what they want the first time, every time representing an ongoing continuous commitment to improvement (Summers, 2009, p. 13).

Correction-verification process - process used by the Academic Learning Center to make corrections to and verify monthly student usage data collected using the *AccuTrack* database.

DMADV - the five phases of the Six Sigma process improvement aimed at creating a new product or process design. The five phases are Define, Measure, Analyze, Design and Verify (Brue, 2002, p. 173-175).

DMAIC - the five phases of the Six Sigma process improvement aimed at improving existing processes that are not efficient. The five phases are Define, Measure, Analyze, Improve and Control (Brue, 2002, p. 90-104).

First generation - a college student who is the first in their immediate family to attend college.

4-D Model - one of two process used to conduct the Appreciative Inquiry process. The process involves four phases: Discovery, Dream, Design, and Destiny (Peaslee, 2014)

4-I Model - one of two process used to conduct the Appreciative Inquiry process. The four phases of the process are Initiate, Inquire, Imagine, and Innovate (Peaslee, 2014).

Higher Learning Commission (HLC) - an independent corporation that was founded in 1895 as one of the six regional institutional accreditors in the United States (HLC, 2015).

Math and Science Services - the tutoring unit of the Academic Learning Center providing academic support for mathematics and science courses.

PBRN - Practice-based research network

Regional accreditation - a type of educational accreditation of schools, colleges, and universities granted by one of seven regional United States accrediting agencies (Wergin, 2005).

Specialized accreditation - also known as professional accreditation focuses on specific disciplines such as law, medicine and education within an institution (Wergin, 2005).

Statistical Quality Control (SQC) - "process wherein statistical data are collected, analyzed, interpreted to solve problems" (Summers, 2009, p. 11)

Student Support Services (SSS) - the advising unit of the Academic Learning Center that is federally funded.

Supplemental Instruction (SI) - an academic assistance program that utilize peer-assisted study sessions.

TEAC - Teacher Education Accreditation Council

Tech Team - the team in the Academic Learning Center responsible for collaborating with ITS-User Services to purchase technologies, trouble shoot and resolve technology and software related problems within the department.

Testing Services - the examination unit of the Academic Learning Center that administers academic and standardized tests.

Sign-in-sign-out errors-errors made by students and staff when signing in and/or signing out of the *AccuTrack* system. These errors include signing in for the wrong tutoring service or course, not signing in or not signing out, transposing letters and/or numbers in names and ID numbers, entering incorrect names, and name changes.

Special populations - as defined by the Carl D. Perkins Career and Technical Education Improvement Act of 2006 are “individuals with disabilities, individuals from economically disadvantaged families, including foster children, individuals preparing for nontraditional training and employment, single parent including single pregnant women, displaced homemakers and individuals with other barriers to educational achievement, including individuals with limited English proficiency” (California Department of Education, 2015).

System-to-System (S2S) - strategic planning meetings that help keep everyone informed and updated on progress being made towards meeting the target goals.

Under-prepared students - students who are academically underprepared as a result of prior educational experience including academic failure, poor preparation, and low expectations (Miller & Murray, 2005).

Well-being - as defined by Dr. Carl Hostetler is “the satisfaction with one’s most major informed desires, taking one’s life, or a portion of it, as a whole” (As cited in Job & Sriraman, 2013, p. 87).

Writing Center (WC) - the tutoring unit of the Academic Learning Center that provides instructional services for writing projects.

CHAPTER 2

REVIEW OF SELECTED LITERATURE AND RESEARCH

Total quality management (TQM) and the quality improvement process have been used successfully by the business sector to make improvements in products and processes. Struggling organizations who wanted to reverse trends of finishing the year in the red or barely making a profit have since the 1960s used quality management to turn their organizations around and improve their profit margin and market share. These struggling organizations looked to quality systems such as the Malcolm Baldrige National Quality Award, ISO 9000, Six Sigma, and others to benchmark themselves against their competitors; develop their organization's vision, goal, and structure; evaluate leadership's commitment to developing and sustaining customer focus; and determine how to better leverage resources to meet customer needs. Table 1 provides an overview of some of these total quality models.

According to Sirvanci, "TQM models, based on the teachings of quality gurus, generally involve a number of 'principles' or 'essential elements' such as top management's leadership, teamwork, customer focus, employee involvement, training, continuous improvement tools, and several other elements, which are all required for successful TQM implementation" (2004, p. 382). Although different, these TQM tools have characteristics in common and have a proven track record that makes them viable candidates for use in the educational sector. However, because many total quality management and continuous improvement processes and tools have deep roots in the business sector, educators are reluctant to implement them in their educational institutions and resist any evaluation process that resembles these models. This literature review provides an overview of some of the total quality methodologies, their use in various sectors, including education, benefits and drawbacks highlighted by other researchers, and the varying viewpoints of educators on what role these quality processes play in the accreditation of higher education institutions.

Table 2. *Quality management models*

Model	Definition
Total Quality Management (TQM)	A comprehensive management approach which requires contribution from all participants in the organization to work towards long-term benefits for those involved and society as a whole.
European Framework for Quality Management (EFQM) Excellence Model	Non-prescriptive framework that establishes nine criteria (divided between enablers and results), suitable for any organization to use to assess progress towards excellence.
Balanced Scoreboard	Performance/strategic management system which utilizes four measurement perspectives: financial; customer; internal process; and learning and growth.
Malcolm Baldrige Award	Based on the framework of performance excellence which can be used by organizations to improve performance. Seven categories of criteria: leadership; strategic planning; customer and market focus; measurement, analysis, and knowledge management; human resource focus; process management; and results.
ISO 9000 Series	International standard for generic quality assurance systems. Concerned with continuous improvement through preventative action. Elements are customer quality and regulatory requirements and efforts made to enhance customer satisfaction and achieve continuous improvement.
Business Process Re-engineering	System to enable redesign of business processes, systems and structures to achieve improved performance. It is concerned with change in five components: strategy; processes; technology; organization; and culture.
SERVQUAL	Instrument designed to measure consumer perception and expectations regarding quality of service in five dimensions: reliability; tangibles; responsiveness; assurance and empathy; and to identify where gaps exist.
Source: Becket, N. & Brooks, M. (2008). Quality management practice in higher education-What quality are we actually enhancing? *Journal of Hospitality, Leisure, Sport, and Tourism Education, 7*(1), 44. doi:10.3794/johlste.71.174	

Quality Improvement in Accreditation

The American higher education process has seen several transformations in the last two decades. A 1992 extension of the Higher Education Act was the starting point of the federal government's efforts to evaluate quality in higher education (Wergin, 2005). Wergin provided a historical perspective of the accreditation process, summarizes accreditation and assessment literature, and highlights the role legislation and philosophical changes on how the public views education are driving the current quality improvement approach to assessing higher education institutions.

Many educational institutions must obtain regional and specialized accreditation. Regional accreditation applies to the entire institution, but specialized accreditation applies to the specific professional disciplines within the institution such as medicine, education, engineering, and law. Regional and specialized accreditation agencies have the same mission. They want higher education institutions to shift focus "from external standards to internal processes … and be clear about *their* mission and purposes and how *they* assesses the accomplishment of these" (Wergin, 2005, p. 40).

The quality improvement approach to accreditation, argued Wergin (2005), placed accreditors in a precarious position. This is because "accrediting commissions face the difficult task of both assuring quality and improving quality" in a system many view as "an attempt by insiders to keep the academy safe from public scrutiny" (p. 35). Accreditors are also required to critically assess with integrity peer institutions as well as their own while maintaining strong professional ties with colleagues within these institutions.

Another point of tension to the quality improvement approach to accreditation is the redefining of educational quality using student learning outcomes. Accreditation initially required institutions to evaluate their mission, curriculum, and resources to ensure they were adequate enough to ensure the institution could fulfill its mission and serve its students. However, the focus on learning outcomes causes higher education institutions to take both an internal (inside-out) and external (outside-in) approach to accreditation and be more transparent and vulnerable to public scrutiny. No longer is accreditation focused on what resources an institution has to offer; instead the focus is on how effective the institution is in using the resources provided to it by the government and the general public.

Despite these tensions, Wergin (2005) believed that "accreditation will become a catalyst for institutional change as long as it emphasizes assessment as a tool for improvement and holds the institution and its programs accountable for taking that important and necessary step" (p. 41). However, Wergin did not provide solutions to overcome faculty resistance to how educational quality is defined and measured. What he provides are guiding principles for institutions to follow, resources on the accreditation policy and practice, and models of accreditation.

The two accreditation models he presented are: the Academic Quality Improvement Program (AQIP) and Teacher Education Accreditation Council (TEAC). TEAC is an example of a professional accreditation agency that evaluates teacher education programs using inquiry briefs. Education programs are evaluated on their established mission of preparing educators. Completing the accreditation process using

TEAC helps faculty to know how the education program is performing as a whole. AQIP was developed by the Higher Learning Commission of the North Central Association (NCA). The next section of the literature review focuses on the Academic Quality Improvement Program (AQIP) and how it has been used in the education setting.

Academic Quality Improvement Program (AQIP)

The Academic Quality Improvement Program (AQIP) is the regional accreditation model developed by the North Central Association (NCA) of Colleges and Schools. AQIP is touted by many critics as the educational equivalent of corporate continuous improvement processes. Elder in the article (2004) was captious of AQIP and viewed the model as a way to force total quality management upon educational institutions.

According to Elder, the NCA director, Steven Crow tried to change the vision of higher education to one of entrepreneurialism by introducing total quality management (TQM) principles into the accreditation process. He believes adopting a total quality management approach to accreditation reduces education to a production system in which the product is learning, and teaching is simply another function of the organization. Elder (2004) further argued that when academic freedom competes with entrepreneurialism and competitive team work, academic freedom loses. “When corporate quality improvement measures are employed across an educational institution as a whole, the process of teaching and learning is forced to conform to the corporate model” (Elder, 2004, p. 93).

Furthermore, AQIP has no criteria directly addressing teaching. This is a major oversight considering the teaching and learning process is the central role of higher education. This omission further solidified the corporate view that teaching is a service provided to help students learn and devalues the essential role teachers play in the teaching and learning process. Elder believes this disconnect between teaching and learning reduces teaching to a service provided to students to help them learn and does not take into consideration the intricacies of the teaching and learning process.

Despite Elder's criticism, there are several factors that make AQIP attractive to administrators—it is an alternative to the traditional 10-year review process and the cost is touted to be considerably less. However, Elder highlighted that since AQIP was relatively new, the true cost to educational institutions is not yet known and it is disconcerting that AQIP is supported by individuals such as Michael Hammer. Hammer co-authored the book *Re-Engineering the Corporation: A Manifesto for Business Revolution* (1993). The book focused on how businesses can downsize. Applying such approaches to education, Elder argued, can have radical effects and overlooks the human dimension. Hammer himself later admitted that for an organization to be successful the human dimension must be considered (Elder, 2004).

To reiterate his point that corporate models are inadequate, an overview of AQIP's nine quality criteria is provided in Elder's (2004) article. The AQIP criteria is compared to the seven criteria of the Malcolm Baldrige National Award. Elder is concerned that although the AQIP's nine criteria address collaborative relationships, shared governance is not directly mentioned. Mentioning collaborative relationships, he argues, is merely an illusion that shared governance is a natural part of the AQIP process.

This is important in higher education where decisions pertaining to educational standards are made jointly between faculty and administrators.

Elder (2004) ended his critique of the AQIP process by stating “the central value that governs the mission of higher education is the value of striving for truth freely through shared dialogue. This value is not for sale; nor is it subordinate to business” (p. 101).

Although AQIP is seen by some educators as an effort to “industrialize” education, there are educators who view AQIP as a valuable assessment tool. Yarmohammadian, Mozaffary, and Esfahani (2011) used the nine criteria of the AQIP model to evaluate the quality of medical records courses in four medical universities across Iran.

Yarmohammadian and colleagues (2011) highlighted “there is no consensus on the definition of quality in higher education” (p. 2917). Despite lack of consensus on the definition of “quality,” evaluation still remains one of “the strongest tools for strategic development in higher education” (p. 2917). Hence, Yarmohammadian and his colleagues chose to use AQIP as a quality assessment tool because they wanted to capture the perception of both faculty and students on the nine AQIP criteria. The nine AQIP criteria are: (1) helping students learn, (2) accomplishing objectives, (3) understanding students’ needs, (4) valuing people, (5) leading and communicating, (6) supporting institutional operations, (7) measuring effectiveness, (8) planning and continuous improvement, and (9) building collaborative relationships. The differences between the perceptions of faculty and students were used to make improvements in the medical records courses to better prepare students for the profession.

Yarmohammadian and his colleagues (2011) used modified versions of AQIP questionnaires previously developed for faculty and students. The student questionnaire had 36 questions and the faculty had 41 questions. The reliability of both surveys were tested with the student survey receiving *Chronback Alphas* score of 93.6 and the faculty survey a score of 96.7. Responses to the questionnaire were converted to a 0 to 100 point scale. Items scoring 0 to 33 points were labeled as adverse situations that needed to be improved; scores between 33 and 66 were seen as relatively favorable, and scores between 66 and 100 were favorable.

From the faculty perspective, Yarmohammadian and colleagues found the four universities were relatively favorable to favorable on all nine AQIP criteria. However, from the students' perspective, three of the four universities in the study scored unfavorably on the AQIP criterion, "building collaborative relationships." On the criteria supporting institutional operations two institutions received unfavorable scores from students. There was significant difference between the overall scores on the nine criteria for faculty (75.4) and students (52.3). The research findings identified "building collaborative relationships" and "supporting institutional operations" as two areas that needed to be improved. The AQIP assessment also revealed some faculty lacked current knowledge of what was new in the field of medical record keeping.

Yarmohammadian and colleagues concluded their research findings by stating that as employers' expectations for more competent employees increased, universities needed to pay attention to quality. "AQIP as a model for evaluating quality is applicable to all universities" (p. 2921) and helps to identify the expectations of the faculty and students. Furthermore, by shifting the focus from increasing academic quantity to improving academic quality, AQIP is a continuous improvement tool that educators can use that is in alignment with the 1992 extension of the Higher Education Act to evaluate quality in higher education. Thus providing higher education institutions a method for measuring the quality of their educational programs.

Balanced Scoreboard

Another quality improvement tool developed in industry and tested in education is the balanced scoreboard. The balanced scoreboard was developed by Norton and Kaplan in 1992 and introduced through a *Harvard Business Review* article. The purpose was to provide a tool for organizations to use in translating their vision and strategies into measures and targets. The targets focused on (1) customer perspective, (2) financial perspective, (3) internal and business perspective, and (4) innovation and learning perspective. The financial perspective answers the question of how the organization looks to stakeholders. The customer perspective evaluates how customers see the organization. The internal business perspective helps to identify what the organization excels at, while the innovation and learning perspective identifies how to continue to improve and create value.

Researchers Cullen, Joyce, Hassall, and Broadbent (2003) used the balanced scoreboard to validate their belief. They believe that the private sector has experience managing quality concerns while maintaining financial viability and could serve as an example for public sectors such as education and methods derived in the for-profit sector are adequate tools to be used in the evaluation of educational quality. To illustrate this point, Cullen and colleagues (2003), chose to evaluate the balanced scoreboard "as a way of moving away from monitoring towards the management of quality in higher education" (p. 5).

Keeping the aforementioned in mind, Cullen and colleagues (2003) sought answers to two questions:

1. Can the balanced scoreboard be adapted to recognize the context of a higher education institution with its varying range of stakeholders?
2. Could the scoreboard be applied in such a way that it can be used as a strategic management tool and not just a performance management system?

As part of their research, Cullen and colleagues (2003) developed a balanced scoreboard for faculty at a mid-ranking university in the United Kingdom around the four perspectives mentioned earlier. In developing the scoreboard the researchers found some drawbacks. The connectedness between perspectives is not always transparent to everyone in the organization and it can be difficult to create a balance between the four perspectives.

Despite these drawbacks there were clear benefits to using the balanced scoreboard:

1. A complete strategic structure is created
2. Communication is enhanced
3. Clear performance measures are developed

4. The scoreboard is a simple and multi-dimensional tool with focused efforts to improve performance

The key the researchers found to the successful use of the balanced scoreboard in the educational sector is that the customer perspective, the financial perspective, the internal and business perspective, and the innovation and learning perspective must work in concert with each other and are structured to focus on internal and external aspects of the educational organization. Furthermore, the performance measures developed by applying the balanced scoreboard are tied to the organizational strategy. This is done through a strategy map which highlights the cause and effect relationship between the organization's strategic plan and the performance measures. In developing the performance measures the voice of all stakeholders must be considered and the standards of the competition must be taken into consideration when setting benchmarks.

At the time when this literature review was being written, there was a shortage of research on how to effectively apply the balanced scoreboard in higher education institutions. However, the initial research using the balanced scoreboard conducted by Cullen et al illustrates that total quality management (TQM) tools developed for use in business and industry can be successfully modified for application in education. Cullen and his colleagues' future plan is to conduct an empirical based case study to evaluate the drawbacks and benefits associated with developing a balanced scoreboard in the educational setting.

Global Educational Quality

The research presented thus far on the use of AQIP (Elder, 2004; Yarmohammadian et al., 2011), and the balanced scoreboard (Cullen et al., 2003) in higher education institutions (HEIs) focused on the applying each quality improvement methodology to domestic higher educational institutions. As more students participate in study abroad and foreign exchange programs, higher education institutions are developing international partnerships as a way to enhance the educational experience of their students. These partnerships western educational institutions to not only consider the evaluation of educational quality domestically but internationally. Job and Sriraman (2013) in their research address the need to extend the discussion on how to evaluate educational quality internationally and globally.

However, the fact that there is no consensus amongst regional, domestic educational institutions on how to measure educational quality complicates the issue of how to measure global educational quality. The closest model to measuring global education quality is the international system of evaluation established by the Bologna Declaration in 1999 to ensure equivalent quality in European universities (Job & Sriraman, 2013). The European university system allows for credits to be transferred and that national curriculums focus on similar content to ensure the transferability of degrees.

The authors point out another stumbling block to establishing global guidelines for monitoring educational quality is the idea that only the Western view, particularly the view of the United States, is the best and most effective educational system. Many non-Western countries do not share this view and have experienced the detrimental effect of the West establishing university campuses in their countries. Job and Sriraman (2013) presented the example of General Electric's establishment of the John F. Welch Technology Centre in India. The centre serves as an engineering school; however, the students who attend the school are required to work for GE several years and are not eligible for employment with GE elsewhere. The inventions of these engineers and the patents obtained are sole property of GE. Educational partnerships like this have led to what is referred to as "brain drain," (p. 83) where the talents of native students in developing countries are exploited and or imported to benefit the West.

Lastly, the authors highlighted that establishing global educational standards is hindered by the current system of ranking universities. "The three most respected ranking systems are *US News & World Report, The Times Higher Education Supplement Rankings of Universities* and *Shanghai Jiao Tong University*" (Job & Sriraman, 2013, p. 89). All three systems focus on research and do not consider the holistic view of the university including teaching quality and student learning. Furthermore, the rankings are skewed positively for selecting American universities and often overlook equally acceptable universities in developing countries (Job & Sriraman, 2013).

Job and Sriraman (2013) identified profit, not quality, as the driving force behind American universities expanding to the east. As a result, the majority of the expansions fail because the focus is on the profit margin not the wellbeing of the citizenry. An example of this is Britain. Britain's Higher Education Commission tried to expand into Israel but failed because of a lack of understanding of the culture of the citizens. The British structured their educational offerings around semesters, not realizing Israeli students operated on a quarter system, and most students were used to a more hands-on learning experience instead of lecture based (p. 85-86). This lack of cultural competency brings into question the well-being of students. Job and Sriraman (2013) used Hostetler's definition of well-being when discussing the impact lack of cultural competency has on students' success. Using Hostetler's definition, well-being is as "the satisfaction with one's most major informed desires, taking one's life, or a portion of it, as a whole" (as cited in Job & Sriraman, 2013, p. 87). So, as education crosses national and international borders and the number of for-profit education institutions rise, educators and researchers need to evaluate the impact of educational policies and decisions on the well-being of their students.

Appreciative Inquiry (AI)

Through the concept of Appreciative Inquiry (AI), Fifolt and Lander (2013), have expanded the consideration of well-being in the evaluation of educational quality to the entire educational institution. Appreciative inquiry (AI) is described by Fifolt and Lander (2013) as "a coordinated approach to organizational change that utilizes reflection, introspection, and collaboration to leverage collective strengths" (p. 19). The approach is life-centric in that it focuses on what aspects of an organization contribute to the well-being of stakeholders and the organization itself. The key principles of AI are:

Constructivist Principle asserts that individuals create meaning through their interactions with others. The thoughts we have about the world and what we perceive as reality is based upon interpretation and construction. The realities each person creates from these interactions are an essential component in the Discovery phase of the Appreciative Inquiry process.

Simultaneity Principle revolves around the idea that inquiry and change occurs in concert with each other. Since reality is socially constructed through interactions, the questions asked influence how people think about and do things.

Poetic Principle is built on the belief that people frame their world including organizations based on what is important to them. Appreciative inquiry builds on the emotional and sensory capacities of each individual. This is relevant to the Dream and Design phases of the Appreciative Inquiry process.

Anticipatory Principle states that the movement of the organization is based on what people perceive about the future of the organization. Stakeholders' behavior is a reflection of how they view the organization.

Positive Principle is built on the idea that the mindset of people, whether positive or negative, influences all aspects of the organization including performance, persistence, and resilience.

Wholeness Principle leverages the view that employees have about the organization. Its premise is that what each individual sees is a piece of the larger whole. Wholeness encourages individuals to see their individual contributions in respect of how it influences the whole.

Appreciative Inquiry is conducted using two models, the 4-D and the 4-I models as described in Table 3. A comparison of the two models follows. The major difference between the 4-D and the 4-I model is that stakeholders learn about the Appreciative

Inquiry process in the 4-I model. Three research studies are presented during this review of the Appreciative Inquiry (AI) process; all researchers used the 4-D model to implement their studies.

Table 3**.** *Comparison of the 4-D and 4-I model appreciative inquiry model*

4-D Model		4-I Model	
Discovery	Phase used to discover when the organization was at its best.	**Initiate**	Key stakeholders are introduced to Appreciative Inquiry.
Dream	Based on the Discovery phase results, members envision what the future organization would look like.	**Inquire**	This aligns with the Discovery phase of the 4-D model. Interviews are conducted to find out what people think.
Design	Individuals collaborate to develop the ideal organization.	**Imagine**	Combines the Design and Dream phase of the 4-D model. Interview data is collected, shared and a ground vision for the future is developed.
Destiny	Stakeholders continue to implement changes in order to build the ideal organization.	**Innovate**	This aligns with the Destiny phase of the 4-D model. All members of the organization have the opportunity to partake in the developed vision. This may include modifying the vision.
Fifolt, M & Lander, L. (2013). “Cultivating change using appreciative inquiry.” *New Directions for Student Services*, p. 19-30. doi:10:1002/ss.20056.			

Singleton, Truglio-Londrigan, and Ferrara (2014) used Appreciative Inquiry to make continuous improvements in a Doctor of Nursing Practitioner program. The researchers wanted to find a quality improvement method that would improve and enhance student experiences while meeting the Commission on Collegiate Nursing Education (CCNE) and the Middle States Commission on Higher Education standards for accreditation. The AI model was ideal for helping to develop the doctoral program since it allowed the faculty and students to focus on what was best about their previous teaching and learning experiences and dream about the future of the program. The Appreciative Inquiry process benefitted the Lienhard Nursing College because it gave the staff an opportunity to move away from the "intervene and 'fix'" (Singleton et al., 2014, p. 22) methods of the nursing profession. The AI framework was introduced to faculty and students in the doctorate of nursing practice (DNP) program in 2008. AI served as a program evaluation tool and was a curricular thread in the nursing program.

Although the faculty followed the 4-D model, students were introduced to AI during orientation, early in the coursework and through DNP scholarly projects. During the Discovery phase faculty, students, and clinical agencies were asked what they were doing well in the area they wanted to improve and what did they want to do better. Students were also asked to evaluate the DNP program during and at the end of the semester. Faculty and the program director met to review the assessment and make changes for improvement. The program director met with students to follow up and go over survey results. This process helped the program to make continuous quality improvements that benefitted the students, faculty, and organization.

Based on the reported research results, the impact of using Appreciative Inquiry in the DNP program was profound. The school believes that “doctors of nursing practice, in embracing and practicing Appreciative Inquiry, will change health care” (Singleton et al., 2014, p. 24). Hence, the Lienhard School of Nursing has adopted a culture of ongoing program improvement and faculty model and practice the AI process for students. Furthermore, faculty have developed an appreciation for the impact using AI as a quality improvement tool has on current and future programs.

Allen and Innes (2013) highlighted in their research the impact of using Appreciative Inquiry to overcome “lack of commitment, style of leadership, and emotional distress that causes stakeholders to be resistant to change” (p. 2). Their goals were to:

a. Eliminate any of the stressful and demotivating triggers that might have been associated with implementing the teacher education program, and
b. Conduct a process of review that was all-inclusive, reflective, and forward-looking.

Allen and Ines (2013) shared the results of using the 4-D model combined with the six AI freedoms as an evaluation tool. Educational drama was used to execute the four stages of the 4-D model, and the six freedoms were used to help frame the questionnaire that gauged the effectiveness of AI as an evaluation tool to complete the program review. The six AI freedoms are: (1) freedom to be known in relationship, (2) freedom to be heard, (3) freedom to dream in community, (4) freedom to choose to contribute, (5) freedom to act with support, and (5) freedom to be positive.

Allen and Innes (2013) were successful in reaching their two research goals. Participants in the study felt relaxed and were free to be known in relationship and be heard. Some participants felt that the power structure of the University at times prevented them from freely dreaming or contributing. These participants felt there would be repercussions if they voiced their honest feelings in the presence of upper administrators. Other participants felt that facilitators had too many activities and did not provide adequate time for reflection. All participants believed the retreat provided them the freedom to be positive.

The Appreciative Inquiry (AI) study conducted by Kung, Giles, and Hagan (2013) used Appreciative Inquiry as a course evaluation tool. They wanted to get students' feedback on their "lived experiences" of the course, "the life-centric moments when students felt invigorated in their learning experiences" (Kung et al., 2013, p. 30). Their research focused on a second year teacher education course; the principal investigators were the course lecturer, a trained AI researcher, and a senior colleague. Three questions were to be answered:

a. What are the characteristics of student's life-centric experiences within an early childhood teacher education course?
b. How might these experiences be constructed as provocative possibilities that might create the possibility that students in the future might experience this course in a deep and meaningful way?
c. What specific teaching strategies and learning experiences engendered a greater sense of "life" within the course?

Nine questions were asked of a focus group of students. Responses were collected and analyzed for underlying themes. Students' responses centered around five major recurring themes: in class presentation, getting to know self, the teacher's way of being, provokes reflective thinking, theory-practice, and enduring influences. Responses from the Dream, Design, and Destiny phases were used by the researchers to develop five propositions with action steps. The results indicated students had their most life centric moment when developing their teaching philosophy because the learning activity caused the students to learn about themselves and others, provoked reflective thinking, and learned how to connect theory with practice. In addition, using Appreciative Inquiry as the course evaluation tool allowed students to provide feedback that was not typically gleaned from the traditional course evaluation. The process was found to be user friendly for faculty and students. Students were provided a venue for sharing learning experiences that were meaningful for them. The AI process also provided insight into the depth of the inquiry processes used by students in completing the assignment.

Kung and colleagues (2013) concluded that the Appreciative Inquiry (AI) process would be an effective tool for educators to use in generating life into courses as well as providing a lens into the level of contemplation students experience in learning. Their research supported the idea that there are intrinsic benefits to both teacher and students in embedding Appreciative Inquiry as an improvement and evaluation tool into the higher education system.

Mishra and Bhatnagar (2012) provided examples of case studies illustrating the versatility of Appreciative Inquiry. The first case study involved the British Broadcasting

Corporation (BBC). The goal of the BBC was to improve employee engagement, cohesion, and creativity and overhaul the BBC corporate culture. The BBC leadership embarked on a campaign called *Making It Happen* using the 4-D Appreciative Inquiry model. With staff dispersed around the world most of the BBC Appreciative Inquiry project was completed via the web. Success was attributed to very well-planned exercises and standardized instruments for gathering feedback during the Dream and Design phases. The process generated over 98,000 ideas and had over 10,000 employees participating across the globe. The Appreciative Inquiry process helped the BBC to develop a new corporate culture and image around six aspirational values: trust as a foundation for the organization, focus on the audience of the BBC, delivering quality and value to customers, fostering creativity, respect and celebration of diversity, and the BBC is one unit and great things happen when working together (Mishra & Bhatnagar, 2012).

The second organization case study is the Office of Research and Development (ORD) of the Environmental Protection Agency. The ORD laboratories were not strategically placed to support the mission of the organization and the organizational structure hindered open sharing of knowledge. The Office of Research Development used the 4-I model and were introduced to the AI tools. Over 200 ideas were generated including a new collaborative process for deciding the group's research agenda.

The final case study involved the Vancouver School District. The district used the 4-D and the 4-I model to implement their change process. The 4-D model was used in the district-wide planning process which involved all stakeholders including students. These meetings helped to develop the core objective of the school. Next the 4-I method was used to train and disseminate information to project managers who would be responsible for carrying out Appreciative Inquiry activities within the district.

Based on these three distinct applications of AI, Mishra and Bhatnagar (2012) developed five propositions related to the implementation of Appreciative Inquiry:

Proposition I: For implementing the change process and as part of setting the vision context AI may provide strong foundation for innovative ideas.

Proposition II: In firms where there is a climate of distrust or hyper-competition an organizational development intervention of Appreciative Inquiry will yield higher employee engagement.

Proposition III: Appreciative Inquiry triggers high level of employee engagement in employees, leading to higher ownership of the change process.

Proposition IV: Providing a format for individual inputs enables creativity in the workplace leading to reduction in complexity.

Proposition V: A judicious mix of Appreciative Inquiry and Action Research process interventions can be more effective in a change implementation process than either of the interventions. This is because AI is seen as opportunity centric (focused on the good) while Action Research (AR) is seen as problem centric (focused on what is to be fixed). The two when used together provide balance.

However, researchers should keep in mind that Appreciative Inquiry is an organizational behavior theory based on the premise that every organization has something that works right. Extensively focusing on what is right has its drawbacks and could cause organizations to not directly address recurring problems. The Malcolm

Baldrige National Quality Award overcomes the drawback of the Appreciative Inquiry process and focuses on what an organization does well as well as what it can improve.

Malcolm Baldrige Criteria

The Malcolm Baldrige National Quality Award (101 STAT. 724, 1987) was named to honor Malcolm Baldrige's long-term commitment to making improvements in government effectiveness and efficiency (National Institute of Standards and Technology, 2013). Baldrige served in the U.S. Department of Commerce from 1981 to 1987. The award is to be bestowed upon "companies and other organizations which in the judgment of the President or the Secretary have substantially benefitted the economic or social well-being of the United States through improvements in the quality of their goods or services resulting from the effective practice of quality management" (101 STAT. 725, 1987, p. 2). Public Law 100-007 (1987) outlines the four main purposes of the Malcolm Baldrige National Quality Award:

- To help to stimulate American companies to improve quality and productivity;
- To recognize the achievements of those companies that improve the quality of their goods and services;
- To establish guidelines and criteria that can be used by business, industrial, governmental, and other organizations in evaluating their own quality improvement efforts; and
- To provide specific guidance for other American organizations that wish to learn how to manage for high quality by making available detailed information on how winning organizations were able to change their cultures and achieve eminence.

Organizations that are headquartered in the United States, have been in existence for at least one year, and are in the manufacturing, service, small business, education, health care, and nonprofit sectors are eligible to apply for the Baldrige Award and must complete and meet what is referred to as the “Criteria.” The Criteria is a set of 100 questions that help an organization to (1) align their resources, (2) identify strengths and opportunities for improvement, (3) improve communication, productivity, and effectiveness, and (4) achieve strategic goals (National Institute of Standards and Technology, 2017).

Although the Malcolm Baldrige Award criteria was originally developed for business and industry it was expanded in 1997 to include the education and health care sectors. The names of the seven categories did not change between the business and education sector. However, the descriptions associated with the seven education categories make it clear that the focus is on students; student learning and engagement; educational programming; faculty and staff engagement; and student, faculty and staff empowerment. The seven categories for business and education are compared in Table 4.

Table 4. *Comparison of Baldrige business criteria for performance excellence and the Baldrige education criteria for performance excellence*

Business Criteria	*Education Criteria*
1. **Leadership**: A company's leadership system, values, expectations, and public responsibilities.	1**. Leadership**: A company's leadership system, public responsibility, ethical behavior, public concerns.
2. **Strategic planning**: The effectiveness of strategic and business planning and development of plans, with a strong focus on customer and operational performance requirements.	2**. Strategic planning**: The effectiveness of the organization's strategic objectives and plans in developing student excellence, contribute to long-term productivity and cost containment, and organizational and personal learning.
3. **Customer and market focus**: The company's knowledge of customer requirements, expectations, and preference, improvements on products processes, systems and services.	3. **Student, stakeholder and market focus**: How does the organization engages its customers (students, parents, local businesses, future employers, etc.) for long-term market success.
4. Information and analysis: Investigates the company's use of information and performance measurement systems; improvement of organizational performance, management of information, information technology, and knowledge.	4. **Measurement, analysis and knowledge management**: Investigates the organization's selection and use of information and comparative data; analysis and review of school performance, and its use in planning.
5. Human resource focus: Company's plans and actions that allows employees to perform to the fullest potential and create a high performance work force.	5. **Faculty and staff focus**: addresses key workforce practices directed toward creating and maintaining a high performance work environment, engaging the workforce in order for it to adapt to change and grow.
6. Process management: The effectiveness of systems and processes for assuring the quality of products and services.	6. **Operations focus**: The management of key educational programs, services, work processes in creating value for students, faculty, staff, and other customers, achieving organizational sustainability.
7. Business results: Performance results, trends, and comparison to competitors in key business areas such as customer satisfaction, financial, human resources, suppliers, partners, and business operations.	7**. Organizational performance results**: students' learning results, students' and stakeholder satisfaction results, faculty and staff results, and budgetary results.

Source: Arif, M. & Smiley, F. (2003, p. 755-758). Summers, D. (2009. p. 458-459). National Institute of Standards and Technology. (2013, January). *2013-2014 Malcolm Baldrige Education Criteria for Performance Excellence*.

There are five main reasons an organization should utilize the Baldrige Criteria for Performance Excellence as their tool for organizational assessment and continuous quality improvement. The first two reasons are that the Criteria is adaptable and non-prescriptive. It allows large and small organizations the flexibility to develop quality improvement approaches that are compatible with the organization's needs. Second, the Baldrige Criteria allows the institution and its constituents to develop the organization's profile through a thorough examining of its core competencies, gain an understanding of the regulatory environment in which it will operate, identify governance roles and relationships, and decide how the organization will approach performance improvement and learning (National Institute for Standards and Technology, 2015; National Institute for Standards and Technology 2017).

Third, the Baldridge Criteria are inclusive and focus on all aspects of the organization including its leadership, strategic planning, processes, and partnerships. Hence, all units in the educational institution would be evaluated to concretely identify their contributions in helping the organization meet its strategic goals and objectives. Illustrating how departments are interconnected and impacted by the work each other does is vital for sustainability and longevity. Hence, cohesion and collaboration across the institution are natural outcomes of the Criteria. The Criteria also allows an organization to evaluate its relationship with its partners. These types of partnerships are not normally highlighted in many assessment and total quality improvement programs

The fourth advantage to using the Malcolm Baldrige Education Criteria for Performance Excellence is the Criteria focus on common requirements not specific procedures, tools or techniques. Higher Education departments have specific procedures that each must follow in order to comply with university, state, and federal regulations. If the assessment tool focus is specifically on procedures, tools, and techniques used by each department, the results would be disjointed lists that fail to show the collaboration that takes place between the academic units. The Baldrige Criteria helps educational institutions overcome this. Also, since departments and divisions within post-secondary institutions undergo frequent restructuring, it is important to illustrate the strength of the relationships that exists between the departments. These types of departmental interdependence are a vital part of ensuring that every student attending the institution has the opportunity to be successful.

Finally, the Criteria ensures uniformity across departments. Since each unit of the organization uses the same criteria and core set of values to evaluate its effectiveness in meeting goals and objectives, the assessment process is streamlined and uniform while allowing each unit to maintain its individual function and identity and faculty can maintain their autonomy.

Although the Malcolm Baldrige Performance Excellence Award has been proven to be an effective total quality management program within educational institutions, the literature raises some concerns. The chief concern is that the criteria does not meet the constraints of student variability that instructors encounter in the classroom. This concern is easily overcome since the Baldrige Criteria is a continuous improvement tool, and Criteria 3 and 5 of the Baldrige Education Criteria for Performance Excellence specifically address the interplay between faculty and students.

Six Sigma Case Study

The final continuous improvement methodology to be discussed is the application of Six Sigma in the research of Livingood and colleagues (2015).

Livingood and his colleagues (2015) focused their research on selected Georgia public health organizations to assess the impact of public health based research network quality improvement interventions on the organizational culture. A design of experiment was used with three districts implementing the practice based research network (PBRN) quality improvements intervention and 10 non-PBRN districts. A web-based survey was used to measure the level of improvement in organizational quality improvement culture over a period of 12 months. The 10-question survey was adapted from the Florida county health departments and was validated for the Georgia health system. The survey was administered to informants in each district to obtain their perception of the organization's quality improvement culture. There were 72 and 120 key informants respectively from the quality improvement group and non-quality improvement group.

Three graduate students provided onsite quality improvement technical assistance to the three districts receiving the quality improvement (QI) intervention. Training for the graduate students included weekly seminars on how to use quality improvement (QI) textbooks, collaboration with the University of Minnesota Public Health QI Center, and online training to become Six Sigma certified. Tools used to monitor the quality improvement projects included root cause analysis, Plan-Do-Study-Act (PDSA), and process mapping.

The results of the study showed the healthcare districts who participated in the practice based research network (PBRN) quality initiative had a greater improvement in their perception of quality improvement culture between the pre- and post-survey. Two of the three districts met their quality improvement project goals. In the process of completing the projects the districts discovered other problems with processes. The major hurdle for one district was the inability to work continuously to an optimal point in the process to ensure best results. PBRN districts were more likely to use data to make informed decisions and continue to use quality improvement processes. Agency-wide multidisciplinary collaboration also increased. An unintended benefit of the study was health districts that participated in the PBRN quality improvement initiative received increased leadership support for essential services.

Overall, Livingood and colleagues (2015) achieved their desired results. They cautioned the reader that a single quality improvement project does not create a culture of quality improvement for an organization, and the top down bureaucratic nature of government agencies can be a hindrance to the implementation of quality improvement initiatives.

Summary

The review of literature provides an overview of quality improvement in the higher education accreditation process through the Academic Quality Improvement Plan (AQIP). Cases have been presented demonstrating the successful implementation and application of total quality management techniques and continuous improvement methodologies including the balanced scoreboard, Appreciative Inquiry (AI), the

Malcolm Baldrige National Quality Award, and Six Sigma in education. These studies illustrate that process improvement tools designed and developed for business and industry can be successfully implemented in the education sector.

The reader should note however that not all quality management implementation plans have been successful. According to Srikanthan and Dalrymple (2003), it is estimated that 80% of total quality management implementation plans fail. One reason is that any quality improvement process requires strategic planning. In order to make impactful change, organizations must become adept strategic planners. Strategic planning requires an organization to look forward but also to look backwards. By looking backwards an organization is able to determine what are its strategic challenges and by looking forward it is able to determine its strategies for preparing for the future. Developing a strategic plan forces an organization to identify and evaluate its strengths, weaknesses, opportunities, and threats.

Researchers provide several strategies leaders can take in order to successfully integrate quality improvement as part of the organizational culture (Antony, Krishan, Cullen, & Kumar, 2012; Furst-Bowe & Bauer, 2007; Srinkanthan & Dalrymple, 2003). These include creating and supporting a quality culture and generative learning, making professional development an integral part of institutional planning, developing feedback mechanisms based on continuous assessment, and conveying a clear vision of what the organization is trying to achieve.

According to the 2013-2014 Malcolm Baldrige Education Criteria for Performance Excellence, “your organization’s planning should anticipate many factors, such as students' and other customers' expectations; new education and partnership opportunities; changing economic conditions; …evolving regulatory requirements; changes in community and societal expectations and needs; and strategic moves by competitors and comparable organizations" (National Institute of Standards and Technology, 2013, p. 40). Essential to the success of any strategic plan are accountability and metrics. Who will be responsible for implementing the plan and ensuring the objectives of the plan are carried out? How will success be measured and how will we know we have been successful?

Each of the quality improvement processes presented-- AQIP, the balanced scoreboard, Appreciative Inquiry, and Six Sigma -- emphasize the importance of everyone at the institution buying into the quality improvement process, and the importance of leadership engaging individuals at all levels including faculty, students, and staff in planning and decision making. The leadership criteria is the second highest weighted category in the Baldrige application which indicates how important an organization's leadership is to the quality improvement process. It is the senior leadership that helps to create an atmosphere that fosters innovation; open honest two-way communication; and encourages employees to become engaged in helping the organization meet its mission.

The institution as a whole must develop what measurements will be used to determine success. This will help to ensure that future decisions are fact based; provide baseline data for comparison; and help to communicate and clarify the goals that everyone is working to accomplish. Measurements will vary and may include student performance measures, enrollment statistics, employer surveys, etc.

"The greatest challenge for advocates of innovation in higher education has been to break through the defenses of institutions that are well established and not threatened with imminent destruction. An institution that is structured in the conventional manner is largely designed to stay the way it is—to maintain the status quo" (Furst-Bowe & Bauer, 2007, p. 12). Implementing a total quality improvement process into an institution of higher education can be a daunting task. It requires that the entire institution becomes actively engaged in the process. The implementation of the quality improvement process will challenge the traditional beliefs held by faculty, staff and administrators.

CHAPTER 3

METHODOLOGY

Considering the recommendations made by Srinkanthan and Dalrymple (2003), Furst-Bowe and Bauer (2007), and Antony and colleagues (2012) on how to successfully implement quality improvement as part of the organizational structure, the Six Sigma DMADV (Define, Measure, Analyze, Design, Verify) and DMAIC (Define, Measure, Analyze, Improve, and Control) methodologies will be used. The Six Sigma methodologies were chosen because both will help to keep the goal of improving the correction-verification process and building the *Access* database in clear vision for the quality teams. Both methodologies incorporate continuous assessment and considers the customer’s voice, the Academic Learning Center throughout the quality project. In addition, following the DMAIC methodology allows the Academic Learning Center to strategically look back and identify weaknesses in the correction-verification process. Since both the DMADV and DMAIC methodologies are statistically driven, metrics will be developed for measuring success.

The Six Sigma DMADV and DMAIC methods overcome the shortcomings mentioned in the review of literature related to Appreciative Inquiry (AI), the balanced scoreboard, the Malcolm Baldrige Award for Educational Excellence. Specifically, using the DMAIC and DMADV methodologies provide a process for evaluating all steps, including those that do not work effectively, of the correction-verification process. Unlike the Malcolm Baldrige Award for Educational Excellence, Six Sigma provides specific tools to help identify what are the root causes of the problem in the correction-verification process and tools for evaluating the effectiveness of changes made to the correction-verification process.

Finally, the Six Sigma DMADV and DMAIC process improvement techniques have been used by multiple industry sectors including health care, manufacturing, business, and education (Jacobsen, 2011; Lama et al., 2013; Miguel & Andrietta, 2009). However, the Six Sigma DMADV and DMAIC process improvement techniques, according to the literature reviewed, have not been applied in a tutoring or learning center. This research project provides opportunity for the methods to be tested in a unique educational environment. Applying the Six Sigma process improvement techniques in a learning center can positively impact persistence and retention of students at the University, especially students who are underprepared and first generation. Applying the Six Sigma techniques can help to refine existing processes to increase the efficiency of the Center. Having accurate usage data can assist learning and tutoring centers to acquire funding and validate request for increased staffing and extending hours of operations.

Convenience sampling will be used to select the learning center and tutoring program for the study. Specifically, the study will occur in the Academic Learning Center at the University of Northern Iowa. Two Six Sigma teams will be formed. One team will address the inefficiencies related to the *AccuTrack* correction-verification process, and the other team will develop and test the *Access* database and the processes related to its use. Both Six Sigma teams will be led by me, Latricia Hylton, the Math Coordinator.

Methodology for the *AccuTrack* Correction-Verification Process

The DMAIC (Define, Measure, Analyze, Improve, and Control) Methodology will be used to improve the *AccuTrack* correction-verification process. A detailed description of the research process and tools that will be used in the DMAIC Method follows.

The *Define Phase* identifies the problem to be addressed, the customer that will be impacted, and the members of the Six Sigma project team.

The Six Sigma Project Team will consist of me and the the director of Academic Achievement and Retention Services, who also serves as the Tech Team Chair. The customer that will be impacted is the Academic Learning Center and the students who use the services of the center. The problems the Six Sigma team will address are to:

1. Reduce the cycle time for verifying the monthly *AccuTrack* usage report for Math and Science Services (MASS) from an average of 44 business days to 11 business days (0.5 month).
2. Reduce the number of *AccuTrack* errors made by students during the sign-in and sign-out process.

The *Measure Phase* requires the Six Sigma Team to identify the steps to improve the current *AccuTrack* correction-verification process and the corresponding inputs and outputs. During the *Analyze Phase* the root cause(s) that impact the correction-verification process are identified along with the corresponding critical to quality elements and measures that will affect the efficiency of the process. The *Measure* and *Analyze Phases* will incorporate these Six Sigma tools:

1. *Processing Mapping* to map the steps involved in the current *AccuTrack* correction-verification process and the corresponding inputs and outputs associated with each step. The process map helps the Six Sigma Team identify the critical to quality (CTQ) elements that positively and negatively impact the cycle time for the correction-verification reports, helps to maintain control over what steps in the process are changed, and monitors the corresponding impact of each change.
2. *Brainstorming* meetings will be held with the coordinators/directors in the Academic Learning Center as well as the math and science tutoring staff. The ideas generated from meeting with the two groups will be summarized in an affinity diagram. Then, *WHY-WHY* diagrams will be used to identify the potential root causes that influence the cycle time of the *AccuTrack* correction-verification process and the sign-in and sign-out process. Modifications to the correction-verification process that addresses the root causes associated with the cycle time as well as the sign-in and sign-out processes will be made and the new processes tested.
3. The following questions will be used to guide the brainstorming sessions:
    a. What step(s) in the current *AccuTrack* correction-verification process are not working as they should?

b. What can the Six Sigma team do to improve each problematic step in the *AccuTrack* correction-verification process?

c. What factors do you believe are contributing to the sign-in and sign-out errors made by students?

d. What are the common errors being made by students during the sign-in and sign-out process?

e. In what ways can we make modifications to the current sign-in and sign-out process to remedy, decrease, or eliminate the errors?

f. What variables will be measured to gauge whether the improvements decreased the number of sign-in and sign-out errors?

4. *Cause-and-Effect* (Ishikawa) diagrams will be developed for each critical to quality characteristic that negatively impacts the correction-verification process and the sign-in and sign-out process.

5. *Force-Field* Analysis will be used to identify the driving and restraining forces associated with the *AccuTrack* correction-verification process and the sign-in and sign-out process and document the recommended changes made by the Six Sigma Team.

During the *Improve Phase* the critical to quality elements will be dissected and paired with potential solutions identified during the brainstorming meetings. The Improve Phase will use Cause-and-Effect diagrams and Force Field Analysis.

A cycle time of 0.5 months or 11 business days will be used as the capability measurement to determine whether the modifications to the *AccuTrack* correction-verification process netted any improvements. The cycle time will include only days the Academic Learning Center is open for operations and will exclude official university holidays, Saturdays, and Sundays. Since the usage data is verified each month, the cycle time for each month will be a data value.

Data will be compared over three time frames—the fall, spring, and summer semesters. It is conjectured that during the summer semester, the correction-verification cycle time will be reduced and there will be less variability in the number and types of errors made during the sign-in and sign-out processes due to the decrease in usage of the math and science tutoring services offered through the Academic Learning Center.

In the Control Phase of the research the recommendations for improving the *AccuTrack* correction-verification process and the sign-in-sign-out process will be implemented. Recommendations will be implemented systematically to avoid confounding amongst variables. After each recommendation is implemented, measurements will be obtained using the critical to quality measurements defined during the Analyze and Improve Phases**.** The researcher will keep a journal to document the changes made to the *AccuTrack* correction-verification process. A spreadsheet will also be used to track the number and types of errors that are made, the number of drafts that were necessary to complete the process, the receive and return date of each draft of the report, and the final correct and verified report.

The results from each modification will be analyzed using F-Test to detect any variability in the before and after results for the cycle time and the number and types of errors that were detected. A process capability of 0.5 month (11 business days) will be evaluated to find out if it is a realistic measure of cycle time. A run chart will be constructed using the cycle times divided into three subgroups: fall (August through December), spring (January through April) and summer (May through July).

A number of nonconformities charts (c Chart) will be constructed for the sign-in-sign-out process to record the number of errors observed in each monthly report. The errors are the number of sign-in and sign-out entries that are deleted, moved to a different category and/or program, added to the report. Each type of error will be counted and compared. The comparison will be between the number and types of errors made prior to and after the modifications to the sign-in-sign-out process. Hence, the c Charts before and after each process modifications will be compared. Sample size for the c Chart is one month. Using n = 1 month eliminates the variation in the number of days in each month. The c Chart will help to establish limits for the number and types of errors to expect as an inherent part of the sign-in-sign-out process.

Creation and Testing of the *Access* Database

Currently, math and science tutors record relevant information pertaining to each tutoring session and the student tutored using a paper Daily Verification Log. The Daily Verification Log ask tutors to record the date of the tutor session, student’s last name, student’s university ID number, beginning and ending time of the tutoring session, the name of the course, and whether or not the tutoring session was an appointment or walk-in. Each tutor is responsible for keeping track of the students they tutor on the Daily Verification Log and an appointment log kept in the folder of students who are seen by appointment. The Math Coordinator uses the Daily Verification Log and the Individual Appointment log to verify the monthly *AccuTrack* usage report. The goal is to develop a secure, accessible, multi-user electronic database system to record the information captured on the Daily Verification Log and the Individual Appointment log.

The DMADV (Define, Measure, Analyze, Design, and Verify) methodology will be used to develop the database for Math and Science Services. The database will be used to verify the monthly *AccuTrack* usage report, track tutor contact hours with students, verify tutor contact hours needed to obtain tutor certification, and generate detailed reports tailored for partners and supporters of the Academic Learning Center.

During the Define Step the team will identify what are the most important wants and needs for Math and Science Services in the creation of the database and develop the related metrics to be used to measure performance and efficiency. The tool that will be used during this phase is the Force-Field Analysis to identify the driving forces, restraining forces, and actions needed to build the database.

It is in the Measure Step that the metrics developed during the Define Step will be used to collect data and drive the Analyze, Design, and Verify Steps. In the Analyze Step the finished database will be tested by the database designer and the Math Coordinator. Feedback from the designer and Math Coordinator will be used to make adjustments to the design of the database throughout the Design Step. After initial adjustments to the design are made the database will be tested by a subgroup of four math and science tutors, the designer, and the Math Coordinator. Further adjustments will be made to the design of the database to ensure it meets the needs identified by the group. Documentation for using the database will be developed and the process moves to the Verify Step.

During the Verify Step**,** all staff—the ten math and science tutors, graduate student, and the Math Coordinator—use the developed documentation to test the reliability of the database. Feedback will be obtained from users and adjustments made in design and functionality. Each adjustment is tested. Once the database is functioning per the design goals, meets the Math Coordinator's expectations, and returns no errors while being used by multiple users, final documentation is written.

The average *AccuTrack* correction-verification cycle time before the use of the database and the modifications to the correction-verification process will be compared to the average cycle time after the modifications to the correction-verification process are made and the database is used to verify the usage data.

CHAPTER 4

RESULTS

The *AccuTrack* Correction-Verification Process

In Summer 2014, the Six Sigma team held meetings with the coordinators of the other four units of the Academic Learning Center to identify the critical to quality (CTQ) elements that needed to be addressed in the *AccuTrack* correction-verification process. The critical to quality measures identified from the meetings were in four major categories: communication, inconsistencies, technical skills, and missing information. These CTQs are organized through the affinity diagram in Figure 5.

Define Phase

During the brainstorming sessions the Six Sigma Team wanted to answer these questions: what steps in the current *AccuTrack* correction-verification process are not working as they should, and what factors contributed to the sign-in and sign-out errors made by students.

The team discovered several aspects of the correction-verification process that needed to be considered when making improvements. Corrections to the six usage reports was being completed in isolation; however, on multiple occasions students who needed to be added or deleted from one usage report could be found on another unit’s report. A common monthly deadline date for all units to submit corrections to the usage report was not in place; this prevented cross-checking between the six reports. Throughout any given month, multiple individuals, including the coordinators were providing corrections to the sign-in and sign-out data prior to the printing of the monthly reports.

Correction-Verification Process Critical to Quality Elements

Communication

-Lack of communication amongst coordinators

-Lack of communication between Tech Team member making corrections and inputting data and the entire Tech Team

-Lack of documentation of *AccuTrack* system errors

-Lack of communication of when system changes and updates are made

-Not conveying concerns of coordinators to the Tech Team and vice versa

Missing Information

-Data not inputted into *AccuTrack* System when given to person responsible for data entry

-Students do not check-in or check-out

-Tutors do not update appointment log to reflect “No Show”, “Late”, or “Canceled without notification”

-Tutors do not update calendar to state “NO SHOW”

-*AccuTrack* verification database is down

-Lack of compatibility between previous versions of the database and the current

-No accurate record of courses in which students receive tutoring

-No process for verifying time tutors spend “tutoring” which is needed for NTA and CRLA certification

Inconsistencies

-Usage reports printed at random times each month

-Each unit collects different data using different methods

-*AccuTrack* verification database is down

-Lack of uniform process for verifying data amongst coordinators

-Lack of communication during the verification process amongst coordinators

Technical Skills

-Lack of technical knowledge about the *AccuTrack* database to adequately communicate with software designers and Information Technology Services (ITS)

-Inconsistencies in how usage data is entered when corrected

Figure 5. Verification process affinity diagram

There was no established process in place for submitting and tracking when and if these prior corrections were made. Hence coordinators sometimes had to resubmit the corrections when verifying the monthly usage report. Finally, there were inconsistencies in how corrections were made to the *AccuTrack* usage data. The information is summarized in the cause-and-effect diagram in Figure 6.

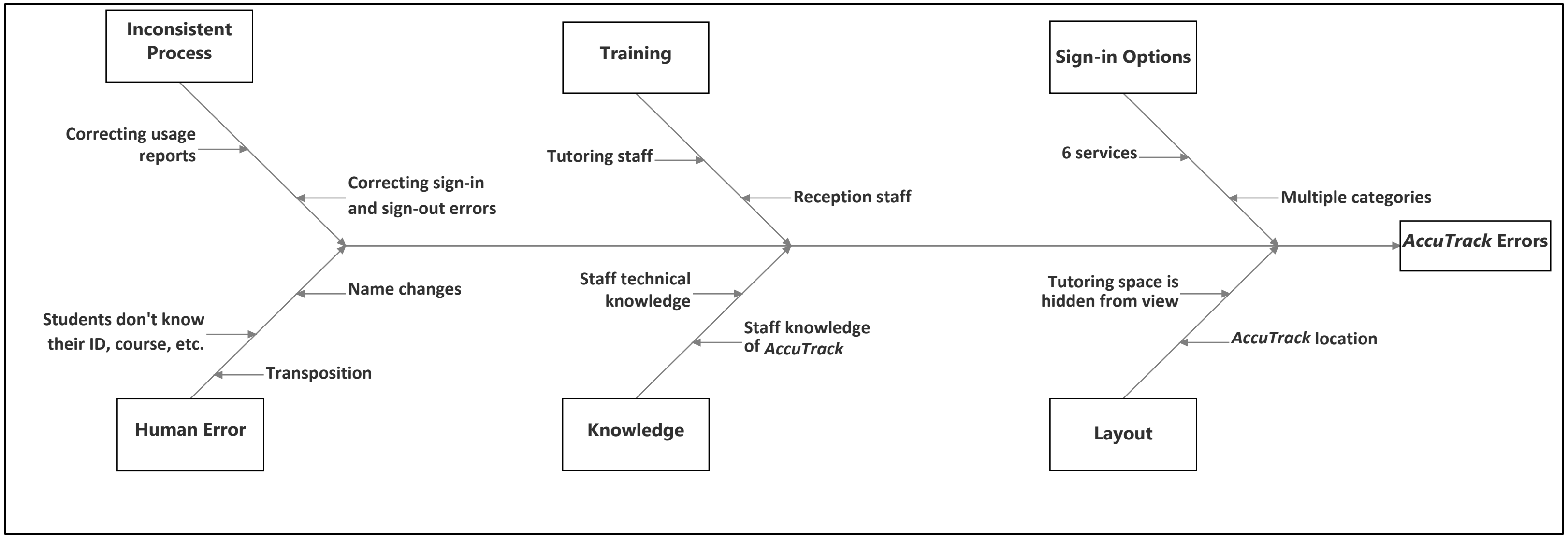

Figure 6. AccuTrack errors: Cause-and-effect diagram

Measure, Analyze, Improve, and Control Phases

There were three major phases to the project: before the process improvement, Phase I, the DMADV/DAMIC phase, and Phase II, the stabilization phase. The pre-process improvement phase was from August 2013 to July 2014 when the old correction-verification process was used. Phase I ran from August 2014 through July 2015 when the DMADV and DMAIC methodologies were being implemented and the correction-verification process was benchmarked. Phase II, the stabilization phase corresponds to the period when the cycle time and number of drafts in the correction-verification process were consistent. The stabilization phase began in August 2015 and ended in December 2016. Table 5 summarizes the primary errors, total errors, and cycle time during the pre-process phase and Phase I of the project. The full data set is found in Appendix C.

Table 5. *AccuTrack correction-verification cycle data August 2013 through July 2015*

Month-Year	Date of First Draft	Date of Final (Correct) Report	Number of Business Days in Cycle	Number of Drafts in Cycle	Primary Errors (Draft 1)	Total Number of Errors (All Drafts)
Aug-13	2/26/2014	5/22/2014	62	No data	13	13
Sep-13	10/8/2013	12/16/2013	48	3	0	0
Oct-13	11/19/2013	4/21/2014	105	4	1	3
Nov-13	12/4/2013	5/22/2013	121	3	24	79
Dec-13	1/3/2014	5/9/2014	92	3	1	8
Jan-14	2/13/2014	3/3/2014	13	2	21	21
Feb-14	3/6/2014	4/21/2014	32	3	40	41
Mar-14	4/7/2014	4/21/2014	11	No data	45	45
Apr-14	5/1/2014	5/22/2014	16	3	21	24
May-14	6/2/2014	6/6/2014	5	2	12	12
Jun-14	7/2/2014	7/18/2014	13	3	54	56
Jul-14	8/1/2014	8/11/2014	6	5	25	30
Aug-14	9/5/14	11/15/14	51	6	22	29
Sep-14	10/24/14	4/12/15	115	7	1	158
Oct-14	11/7/14	4/12/15	110	4	1	108
Nov-14	12/1/14	4/12/15	92	4	57	78
Dec-14	1/14/15	2/24/15	29	4	1	39
Jan-15	2/9/15	4/20/15	30	4	41	43
Feb-15	3/31/15	4/14/15	31	3	83	84
Mar-15	4/13/15	4/22/15	13	3	60	61
Apr-15	5/12/15	5/19/15	6	3	40	46
May-15	5/29/15	6/5/15	6	4	12	18
Jun-15	7/1/15	7/13/15	8	2	5	5
Jul-15	8/4/15	8/7/15	4	1	0	0

Keeping in mind the critical to quality (CTQs) elements and the discoveries made during the Define Phase, the team made changes to the correction-verification process. The first change was to print and distribute all units' prior month's *AccuTrack* usage report the first Friday of the next month to ensure the six coordinators received the usage reports at the same time. The coordinators would make corrections to their respective report and meet the following Wednesday to cross-check the reports.

Errors were categorized as moves, additions, deletions, ID, splits, time, and date. Moves included moving a student from one report to another or from one service category to another. When students were added to the report, it was counted as an addition, and it was counted as a deletion if the student was removed from the report. If a student used multiple services but only signed in for one service category, this was considered a split. Corrections to students' ID numbers and sign-in date and time were labeled as ID, date, and time. All other errors including an incorrect printing of a usage report was categorized as other. Errors were labeled as primary or secondary based on which draft they were discovered. Primary errors were those found on the first draft of the usage report, and secondary errors were other errors discovered after draft one. Total errors include the primary errors plus the secondary errors. In some cases secondary errors include corrections that were not made from draft one of the usage report.

Once the reports were cross-checked they were given to one of the six coordinators who meets with the Tech Team member to make corrections to all the reports. These steps were implemented to reduce the inconsistencies in how the Tech Team member corrected the data in *AccuTrack*. In addition, this allowed the Six Sigma team to track the length of the correction-verification process and the number of revisions made before the usage reports were finalized. A schedule of the usage report print dates, cross-check meeting dates, and dates each coordinator meets with the Tech Team member was created and disseminated (Appendix A).

The first *AccuTrack* reports following the revised correction-verification process were printed in August 2014. The coordinators met to cross-check their reports and the correction process with the coordinator and Tech Team member was followed and the “new” usage reports reflecting the corrections were printed and verified.

The process worked well if there were no further revisions to be made. However, if revision were necessary, the coordinators would bypass the coordinator assigned to execute the revision process with the Tech Team member and give corrections to the different drafts directly to the Tech Team member. The correction-verification process was modified a second time.

First, the two advising programs and the three tutoring units met within their respective service groups to cross-check reports and make corrections. Then, the five coordinators met to make corrections that needed to be made between the advisors and the tutoring units. The revised *AccuTrack* correction-verification process was implemented December 2014 (See Figure 7).

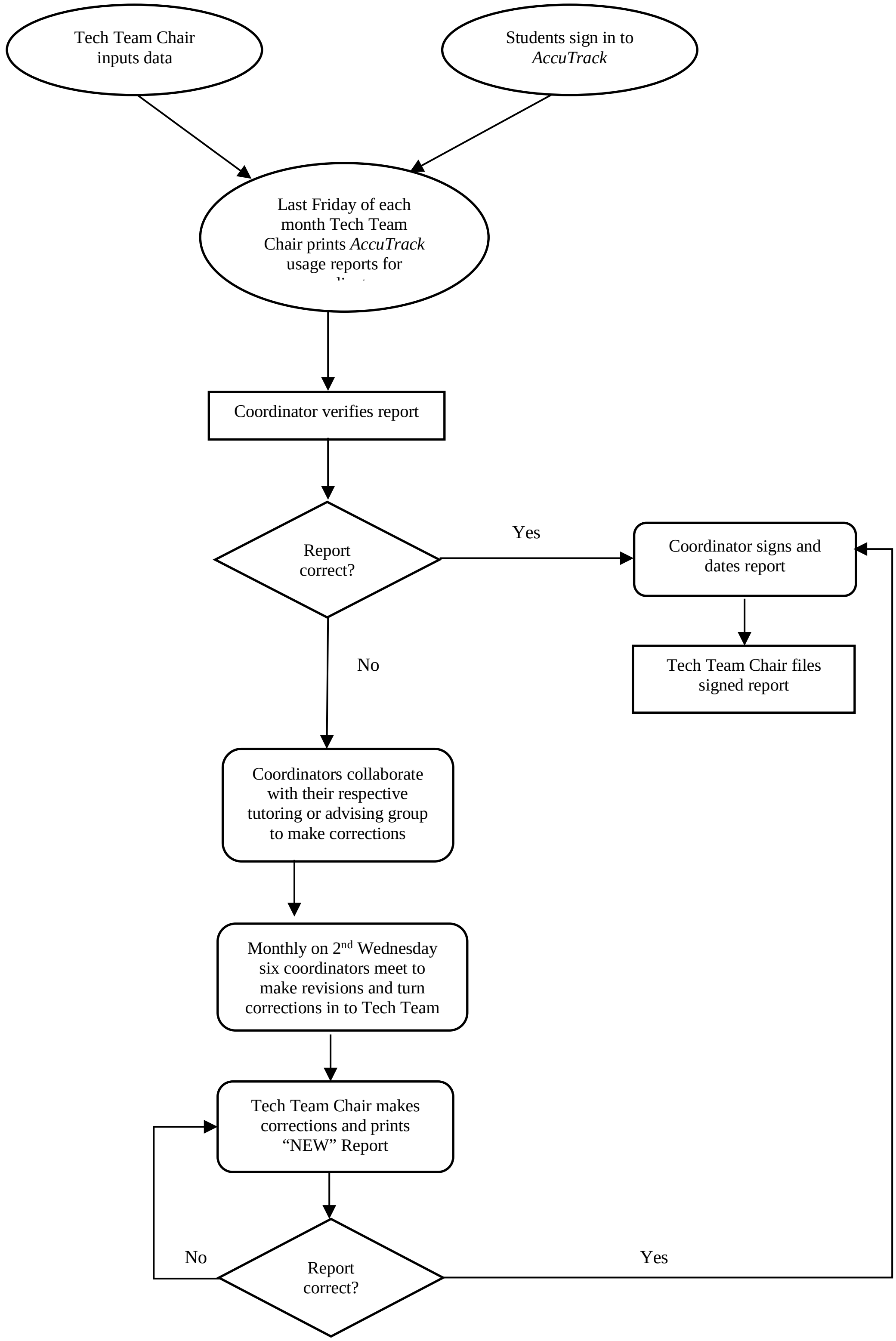

Figure 7. Revised *AccuTrack* correction-verification process

Figure 8, Figure 9, and Figure 10 are run charts depicting the monthly cycle time in business days for the Math and Science Services unit of the Academic Learning Center. Figure 8 covers the Pre-Process period from August 2013 to July 2014 before changes were made to the correction-verification process. Figure 9 shows the cycle times during Phase I, August 2015 through July 2015 when two sets of modifications were made to the correction-verification process. It was during Phase I that the DMADV methodology was used to develop the *Access* database for Math and Science Services. Figure 11 is the box and whisker plot for the three phases. During Phase II, the correction-verification process was relatively stable, and the *Access* database was being used by all math and science tutors to log their tutoring sessions. Phase II cycle data is in is in Figure 10.

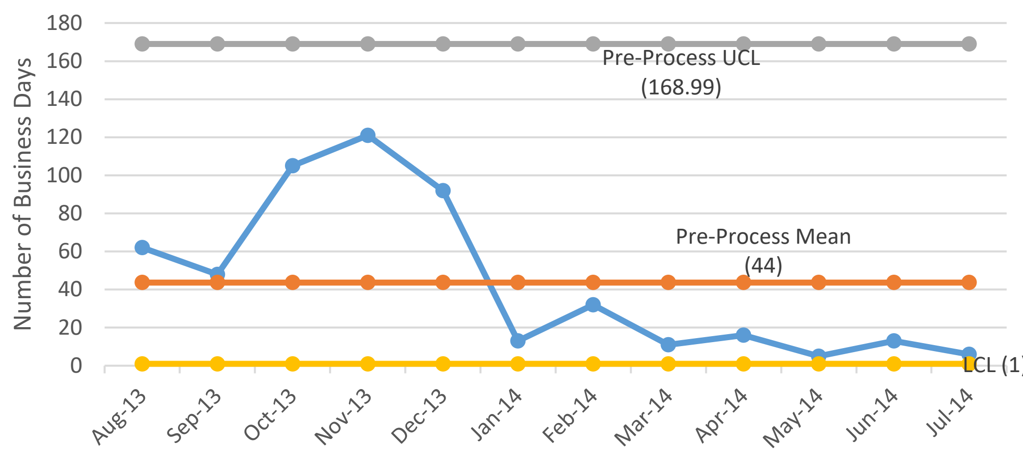

Figure 8. Pre-process MASS *AccuTrack* correction-verification cycle time

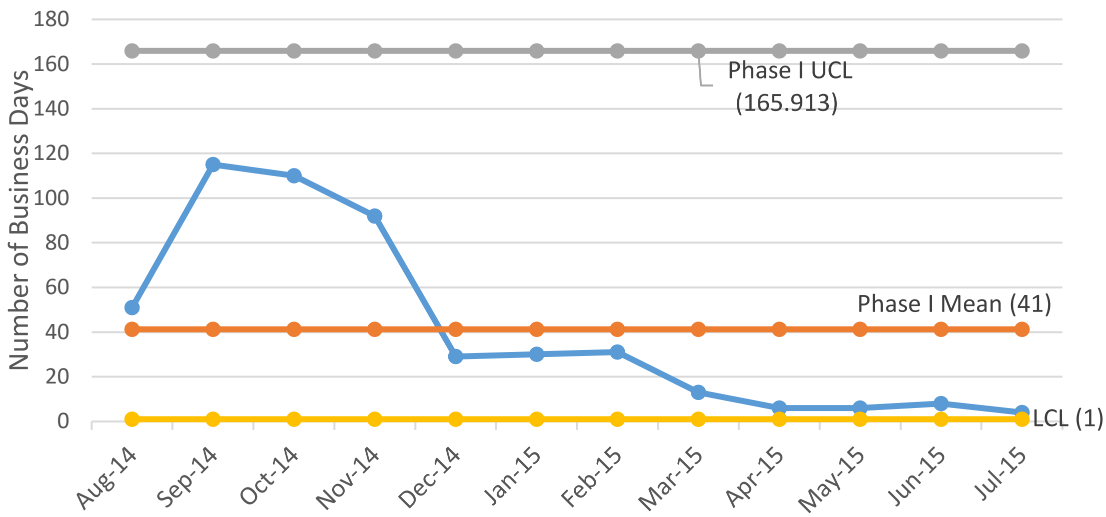

Figure 9. Phase I MASS *AccuTrack* correction-verification cycle time

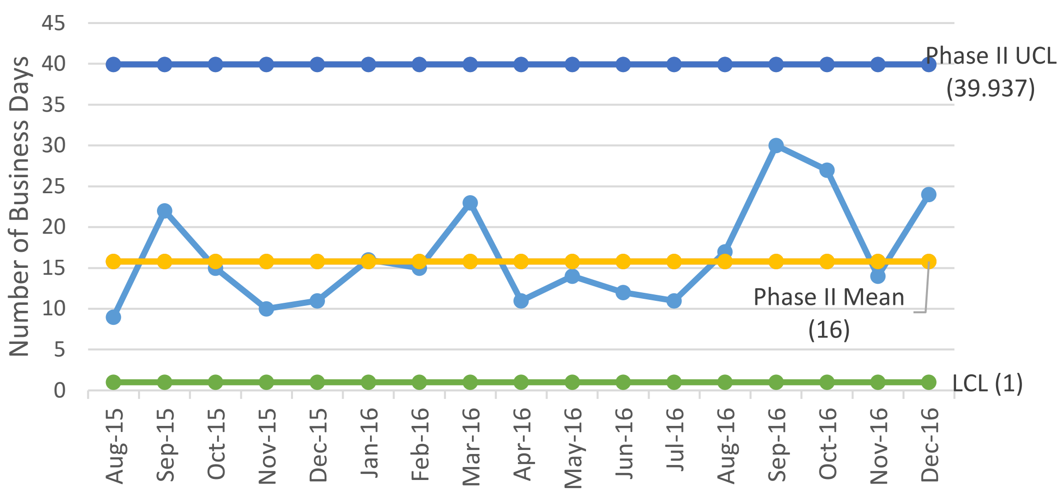

Figure 10. Phase II MASS *AccuTrack* correction-verification cycle time

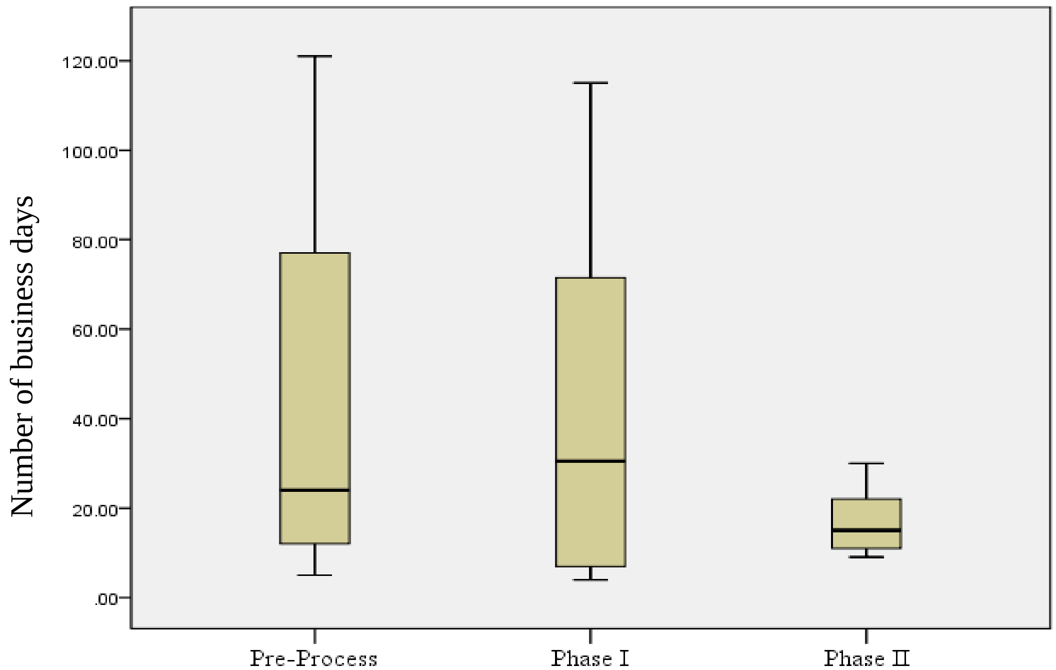

Figure 11: Cycle time box and whisker plot

Recall that during the brainstorming session, lack of technical knowledge about *AccuTrack*, inconsistencies in how usage data was entered, and lack of communication between the Tech Team member making corrections and the entire Tech Team were identified as critical to quality issues (See Figure 5). In Summer 2014, a graduate student was hired to learn the capabilities of *AccuTrack* and how they could be implemented to help improve the sign-in-sign-out process. The graduate student worked closely with the Tech Team chair and was created a list of recommendation on how the Academic Learning Center to use *AccuTrack* more effectively. She recommended that the Academic Learning Center be divided into two “labs”-tutoring and advising and that the number of sign-in options for each program be reduced. Students, depending on which “lab” location they signed into would only be able to view the sign-in and sign-out options associated with the specific “lab.” This would reduce the number of sign-in options the student had to scroll through and restrict the number of initial sign-in options to three for each “lab.”

It was decided that the Tech Team Chair would work with the coordinator of one unit to remedy ALL inconsistencies and verify the usage reports for September through November before moving to the next unit. This ensured that all inconsistencies in how *AccuTrack* was structured for each unit were corrected from September onward.

This provided a systematic method for keeping track of the various revisions made to the usage reports and provided a way for the quality team to gather data on what were common errors or inconsistencies that occurred during the correction-revision process. Common errors included signing students in to the wrong activity and assigning them to the wrong advising or tutoring unit. Duplication of entries was another common mistake.

Multiple crashes in the system throughout the semester was later identified as a reason the usage reports were incorrect. The correction and verification of the usage reports for October through December were delayed due to multiple outages of the *AccuTrack* database. When the *AccuTrack* system is down, students sign in using paper sign-in logs. When using the paper logs students would often omit pertinent information such as course name, date, and sign-in or sign-out time. In addition, the logs were illegible increasing the likelihood of errors when data is manually entered into the

AccuTrack system. The sign-in-sign-out errors data is depicted in Figure 12. The chart represents the total number of errors per month for all drafts and includes primary and secondary errors. Figure 13 is the box and whisker plot for the number of errors.

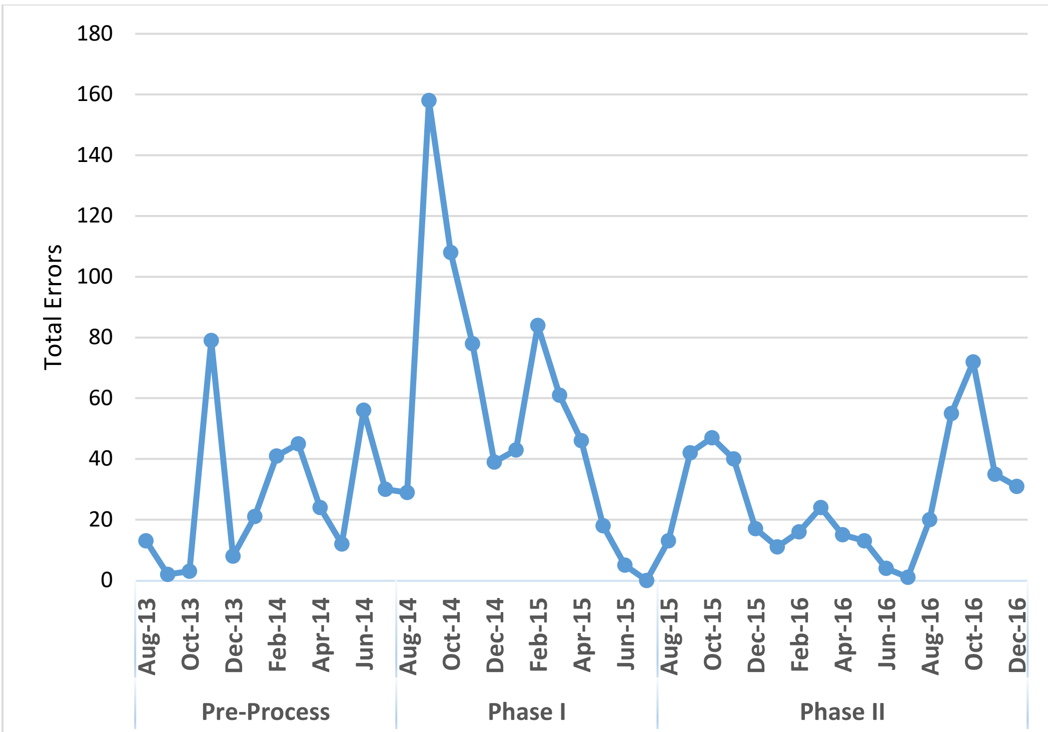

Figure 12. Math and Science *AccuTrack* sign-in/sign-out errors August 2013-December 2016

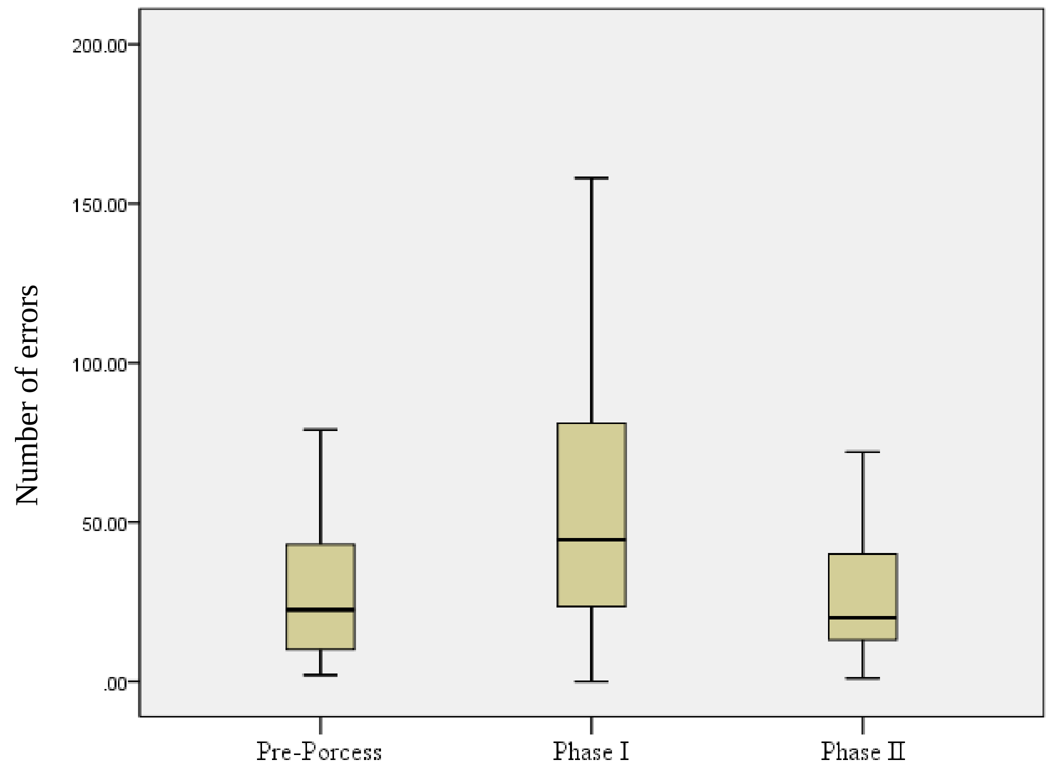

Figure 13: Total errors box and whisker plot

In December 2014, the coordinator who was also the Tech Team chair assumed responsibility for the entire *AccuTrack* system and continued making corrections to the usage reports. This led to the development of a systematic approach to all processes and procedures related to *AccuTrack* and opportunities for the Tech Team chair to work directly with technical support staff at *Engineerica* and UNI which led to the discovery that a dedicated server was needed for the *AccuTrack* system to run effectively and avoid crashing. *AccuTrack* was migrated to a new server in February 2015.

AccuTrack technical staff recommended the database be cleaned on a regular basis to reduce sign-in errors and that a password requirement be placed on the system to alert new users to check-in with office staff for assistance to complete the initial sign-in process. Cleaning the *AccuTrack* database required that the sign-in querries be run on a regular basis to identify who has not officially signed out of the center. This is done at least once per week by the Tech Team chair. Administrator access to *AccuTrack* and the number of work stations the software was loaded on was also restricted.

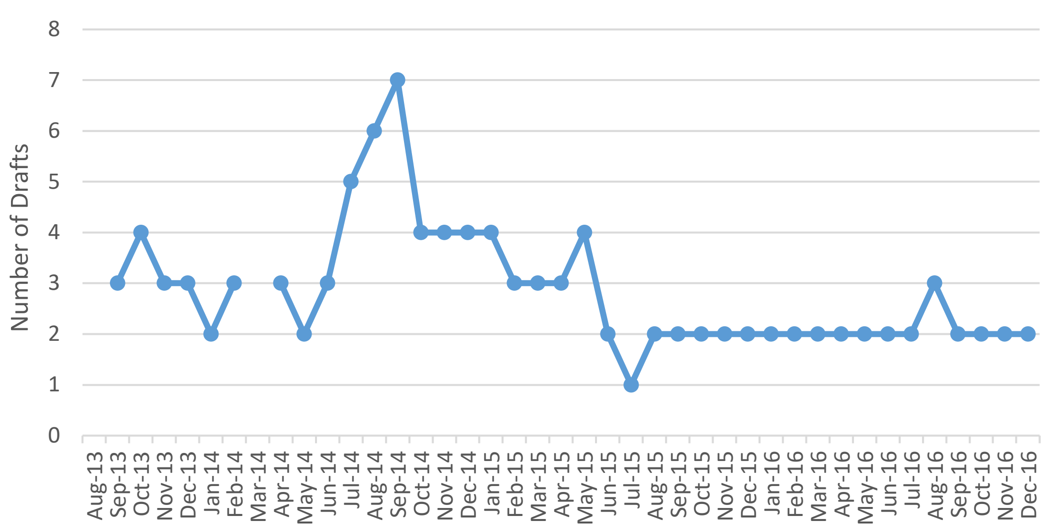

Figure 14. Number of drafts in the correction-verification cycle August 2013 to December 2016

An *AccuTrack* Change Form (Appendix B) was developed in Fall 2016 by one of the Tech Team members. The form provided a consistent method for all staff to submit corrections to the usage data throughout the month. All submitted change forms are returned to the respective program coordinator with the monthly *AccuTrack* usage report. Figure 14 shows the number of drafts needed to complete each month's correction-verification cycle from the Pre-Process phase through the Stabilization Phase. Note draft count values are missing for August 2013 and March 2014 as the various drafts needed to complete the correction-verification process were not consistently archived before the process improvement project began.

Development of *Access* Database

Math and Science Services (MASS), in terms of the number of staff, is one of the larger units of the Academic Learning Center. MASS is unique in that it delivers tutoring services to students using both the walk-in and appointment methods. Tutoring staff use a daily verification log to keep track of each student tutored and an Individual Appointment log to summarize the specifics of each individual appointment. The MASS coordinator uses staff's completed daily verification logs, staff's calendars, and student's appointment logs to verify the unit's monthly usage report. Because a student may begin a tutoring session with one tutor and end the session with a different tutor, the director must cross verification logs to ensure the full length of the student's visit is recorded. Once the verification is complete the MASS coordinator returns the usage report to the Tech Team member and initiates the verification process described in the Figure 7.

There were three stages to the development of the *Access* database. The Design phase took place during the Summer of 2014 with the design and redesign of the database. The pilot testing to measure and verify took place in Fall 2014 followed by the

Control and Design Phases running from Spring 2015 to Fall 2016. A full outline of each stage of the development of the database can be found in Appendix K.

Define Phase

To reduce the time it takes to complete the usage report for Math and Science Services (MASS) the team recommended that a Google database similar to those used by the College Reading and Learning coordinator and the Writing coordinator be used. The database would provide an accessible, centralized location for the math and science tutors to log the students they tutored during walk-in and appointment hours. The database would eliminate the need for the coordinator to utilize the Individual Appointment logs, tutors' calendars, and the Daily Verification logs to verify the monthly usage reports. There were concerns about the security of the Google spreadsheet and violating FERPA regulations; so, the MASS coordinator opted to use *Access* database instead. To justify the creation of this database, a force-field analysis was performed to identify the driving and restraining forces listed in Table 6.

Table 6. *Force-field analysis: Create Access database*

Driving Force	**Restraining Force**
1) Reduces the number of documents to check in order to verify user information 2) Ability to run specific queries on data to answer partner/financial supporter questions 3) Ability to track which courses students received tutoring for 4) Ability to keep track of appointment versus walk-in statistics 5) Ability to run statistical analysis on student and staff data 6) Make previous years information on students accessible to current tutors	1) Tutors will need to keep database updated weekly 2) MASS coordinator and tutors will need to maintain learn how to use *Access* 3) Need a storage space for database that is accessible to all staff 4) Using the database must be incorporated into the tutor training curriculum 5) Work hours of tutors will need to be restructured to include time for data input

Actions
1) Meet with graduate student and ITS User Services to discuss the idea of creating the database 2) Meet with graduate student to decide the structure of the database 3) Construct the database in Summer 2014 4) Pilot the usage of the database during Summer 2014 using usage information 5) Make changes to the database 6) Password protest database and move to public drive 7) Decide team members that will help further "test" the database reliability and functionality 8) Inform staff of the new process for keeping track of the data 9) Train staff on how to use the *Access* database 10) Fall 2014 test functionality and reliability 11) Assign staff office hours to enter data 12) Test database using Fall 2014 (September through December) *AccuTrack* usage reports 13) Revise database structure per team members feedback 14) Implement full database usage in Spring 2015 15) Collect data in Spring 2015 and revise process as needed 16) Develop documentation for using the database

Measure, Analyze, Design, and Verify

The first database for Math and Science Services was designed in Summer 2014 using *Access* and was tested by the designer and the MASS coordinator. The initial design of the data base captured essential aspects, student's name, university ID number, tutor's name, date of visit, beginning and end time of visit, course name, the reason the student utilized the center, and how the tutor assisted the student, of the paper versions of the Daily Verification log and the Individual Appointment log. Since the databases was stored on the department's public drive, it was password protected to safeguard student's identity and ensure privacy. Simple queries were designed to obtain information such as the number of visits made by students, number of unique visitors, hours of tutoring, and course data. Additional queries were designed to make it easier to find students who were already entered in the database and avoid making duplicate entries.

The database was tested on a larger scale by a team of tutors including those who had tutoring appointments during the Fall 2014 semester. The number of pilot users was limited so functionality and design problems with the database could be identified and resolved systematically. Two sub-teams of tutors were assigned to assist the programmer and test the database. The first sub-team was responsible for testing the verification components of the database. They entered the walk-in verification data of all tutors and provided feedback to the designer on problems they encountered as users of the database, made recommendations for changes, and developed documentation. The sub-team decided that tutors should turn in all verification logs when they were completely filled instead of waiting until the end of each month so the user's information could be entered in a timely manner into the database.

The other sub-team consisted of six tutors who were scheduled to take appointments with students during the semester. This group focused on the appointment tracking feature of the database and were responsible for providing feedback to the programmer on problems they encountered during use and make recommendations for changes and improvements. Two members of the appointment verification sub-team were also members of the walk-in verification sub-team and worked closely with the programmer to develop the documentation for the database, test new features, and provide feedback on modifications to be made.

The *Access* database was first used to verify the September 2014 MASS usage report. After completing the correction-verification cycle several discoveries were made. First, not all the tutors turned in their verification logs for the verification team to enter students into the *Access* database. Second, not all the tutors who had appointments kept the database version of the appointment log updated.

To resolve the afore mentioned issues, new due dates for submitting the paper verification logs to the sub-team responsible for inputting walk-in verification data were established. The team agreed to use the 15th and 30th of each month as the new due dates. These new dates gave the team ample time to enter the data into the *Access* database in order for the coordinator to use the database to verify the *AccuTrack* report. In addition, members of both sub-teams were given permission to utilize their office hours to enter data into the database.

Another change made to the process was to assign tutors who had walk-in tutoring only to a specific member of the walk-in verification sub-team. Doing this gave each tutor a clear structure of who to turn their verification logs into and helped the pilot team to follow up with tutors who did not turn in their logs on time. More advance queries were designed that allowed the coordinator to search by parameters such as date, run usage reports by a specific course or department, and calculate the number of hours tutors spent directly tutoring students.

The coordinators continued following the revised *AccuTrack* verification process and Math and Science Services integrated fully the use of the *Access* database to track the usage data. In Spring 2015, the reliability and efficiency of the database was also tested with the thirteen math and science tutors. Each tutor was given one hour per week of scheduled office hour to enter the usage data. The tutors were trained by the programmer on how to use the *Access* database and assumed responsibility for entering the walk-in and appointment usage data of their students.

However, with multiple users more problems were discovered with the database. With multiple users, the system required parameters for queries to be entered twice before executing the query. This problem was fixed. Sometimes entries made by tutors would not automatically save. This was remedied by having users click the “Add Another Record” button versus the “Close Form” button after each entry. To ensure the data was entered in the database in a timely manner, a reminder email was sent to the tutors two to four days in advance of the 15th and 30th of each month.

In Summer 2015, a new graduate student assumed responsibility for managing and maintaining the *Access* database and developing an extensive trainer's guide to be used for new employees. For Academic Year 2015-2016, returning and new staff were trained on how to use the database. Testing of the database's reliability and functionality continued. In August 2015, the database crashed and all data for May 2015 was lost. The student table that serves as the data sources for all student related queries was accidentally deleted in August 2016. The team used the corrected May 2015 *AccuTrack* report to renter the data into the database. Further protocol was set for backing up the database on a weekly basis and using a copy of the actual database as the sandbox for training staff. To avoid duplication of entries, validation restrictions were placed on all items that were automatically pulled from prepopulated data tables. For example a validation restriction was placed on student identification numbers to avoid duplicating students or entering an invalid sequence of numbers as an ID number. Data was collected on the number and types of errors made by staff when logging tutoring sessions in the database. Errors were in two categories—not in database and other. Errors categorized as "not in database" were entries not logged in the database that should have been. Errors associated with misspelling of students' names, incorrect ID numbers, incorrect date, incorrect time, or incorrect course were categorized as other. All errors associated with logging the tutoring sessions are considered primary errors since correcting the errors does not require multiple drafts of the Daily Verification log or the Individual Appointment log.

The total errors associated with logging the math and science tutoring sessions in the MASS A*ccess* database are recorded during the Fall 2014 to Fall 2016 is in Figure 15. The first use of the database was in September 2014; hence, no data is shown before September 2014. Fall 2014 was the pilot semester with limited use; full use of the database by all staff occurred in Fall 2015.

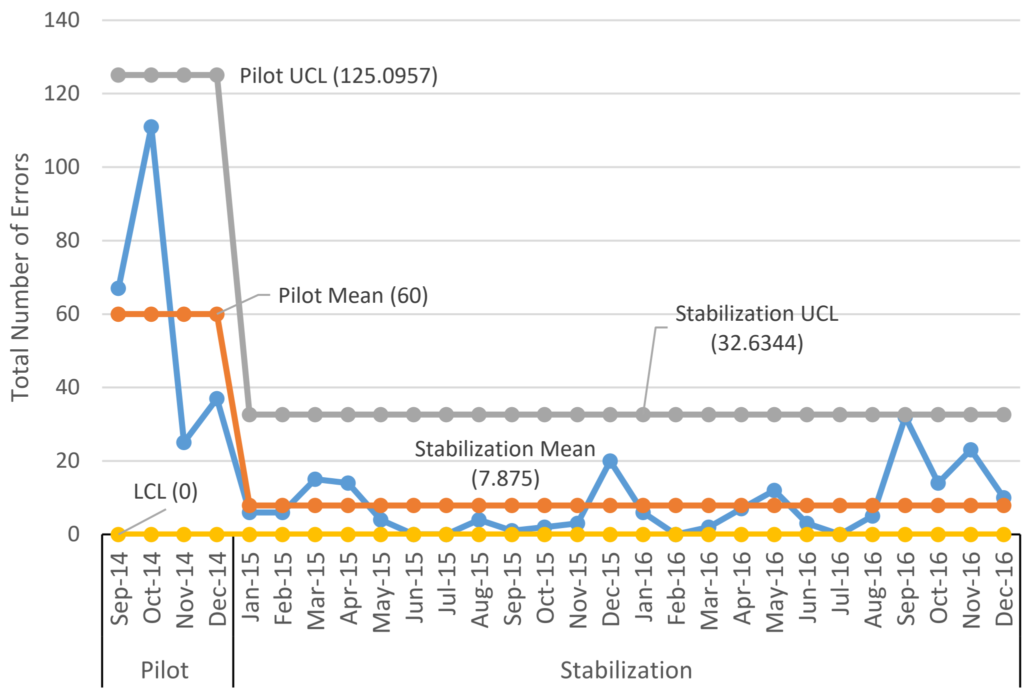

*Figure 1*5. MASS *Access* database errors
September 2014 to December 2016

A two-sample t-Test of equal variance was performed on the error data from Fall 2014 to Summer 2015 and from Fall 2015 to Summer 2016 to find out if the new *Access* database protocols had any effect on the number of errors made by tutors when entering data. There was a significant difference in the number of errors made by tutors when entering data into the database The p-value (ρ=0.0255) is smaller than the 0.05 alpha value. The summary statistics for the t-Test are in Table 7**.** Raw data is in Appendix C, and the time line for developing, testing, and verifying the MASS *Access* database is in Appendix K.

Table 7. *t-Test results MASS database errors*

	After	*Before*
Mean	5	25.90909
Variance	33.81818182	1192.891
Observations	12	11
Pooled Variance	585.7575758	
Hypothesized Mean Difference	0	
df	21	
t Stat	-2.069661121	
P(T<=t) one-tail	0.025504658	
t Critical one-tail	1.720742903	

CHAPTER 5

DISCUSSION AND CONCLUSION

Observations

There were four objectives that the Six Sigma team wanted to achieve through the use of the DMADV (Define, Measure, Analyze, Design, Verify) and DMAIC (Define, Measure, Analyze, Improve, Control) methodologies:

1. Reduce the number of errors made by students during the sign-in-sign-out process;
2. Increase the accuracy of the student usage data for Math and Science Services (MASS);
3. Reduce the number of documents used to correct and verify the monthly *AccuTrack* usage report for Math and Science Services (MASS); and
4. Reduce the cycle time for verifying the monthly *AccuTrack* usage reports for Math and Science Services (MASS) from one month to 1.5 weeks (11 business days).

The results of using the Six Sigma DMAIC and DMADV methodologies are:

- The newly developed *Accutrack* correction-verification process became more efficient and reduced the cycle time from an average of 44 days to 16 days.
- The newly developed *AccuTrack* correction-verification process reduced the cycle time for completing the six Academic Learning Center program usage reports from 40 hours to 8 hours.

- The *Access* database did not reduce the number of documents used in the Math and Science Services (MASS) correction-verification process. The database made the process more efficient by reducing the number of hours to complete the *AccuTrack* usage report from 8 hours to 4 hours.
- The *Access* database did increase the accuracy of the usage data for Math and Science Services.

Dividing the Academic Learning Center into two "labs," decreasing the number of sign-in options, and requiring a password for new users during the sign-in process did decrease the number of errors made by students during the sign-in-sign-out process. The one way ANOVA with $\alpha=.05$ indicates that there were statistically significant differences between the error data for the three phases $p=0.032$, $F_{(observed)} = 3.757$.

Recall that the Six Sigma team focused on completely rectifying each unit's *AccuTrack* sign-in structure and usage reports September through November 2014 causing the correction-verification process to be extended. If the error data for the three months were removed the mean for Phase I changes from 55.75 to 36.11. From the beginning of the Six Sigma project in August 2014 to August 2016, the average number of errors on the Math and Science Services *AccuTrack* usage report decreased from 27.83 to 20.25 average errors per report (Table 8). The majority of errors were made from students signing in for the wrong course or not signing in at all.

Table 8. *Descriptive statistics for MASS AccuTrack error data*

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min	Max
Pre-Process 2013-2014	12	27.8333	23.53656	6.79442	12.8789	42.7878	2.00	79.00
Phase I 2014-2015	12	55.7500	45.59530	13.16223	26.7801	84.7199	.00	158.00
Phase II 2015-2016	17	26.8235	19.29778	4.68040	16.9015	36.7455	1.00	72.00
Total	41	35.5854	32.33649	5.05011	25.3787	45.7920	.00	158.00

Examining the *AccuTrack* error charts, we note the number of errors peaked during the second month of each semester, usually September and February, and during midterms in October and March. The increase in errors can be attributed to an increase in the number of new and returning students using the center and increase in the number of days the center is open. As conjectured, the number of errors decreased during the summer semesters.

The *AccuTrack* run chart (Figure 12) depicts the errors made by students. The MASS database run chart shows the errors made by staff when inputting student usage data in the *Access* database (Figure 14). Another difference between the student usage data recorded in *AccuTrack* and the *Access* database is *AccuTrack* records the length of time the student spends in the center while *Access* records the length of time a student spends directly with the tutor.

According to Figure 14, the number of errors made by staff stabilized between January 2015 and August 2016; on average staff made between zero and 15 errors when inputting information into the database. Between September 2016 and December 2016, this changed. Part of the change could be attributed to the fact that 60% of the math and science tutors were new compared to 30% between January 2015 and August 2016. Omitting students from the database was the majority of the errors made by staff. Staff were not recording students whose tutoring session was less than 10 minutes. The *AccuTrack* system records every student who signs in regardless of the tutoring session length.

Although designing and implementing the database added to the workload of the math and science tutors, the database did help to increase the accuracy of the student usage data. We are able to catalog the specific courses students receive tutoring for as well as the department and college that offers the courses. These statistics are important when we seek support to expand tutoring services. Data obtained from the use of the *Access* database has helped us to build tutoring partnerships with the Physics and Chemistry departments.

Queries were developed to generate student usage data by course, department, and college. The exact hours each tutor spent directly tutoring students can be calculated and verified through the database. This information is needed for National Tutor Association (NTA) certification of the math and science tutors.

The *Access* database did not reduce the number of documents used to correct and verify the monthly *AccuTrack* usage report for Math and Science Services. Sometimes staff inadvertently did not log students into the database or record students on the Individual Verification log depending on the length of the tutoring session. Hence, at times the staff's calendar, the appointment logs, and/or the Individual Verification log were used in the verification process. In Spring 2017, staff were required to verify all students entries were inputted in the database before submitting the paper Individual Verification log to the Math Coordinator.

The final goal of the Six Sigma project was to use the DMADV methodology to reduce the cycle time for verifying the monthly *AccuTrack* usage reports for Math and Science Services from 44 business days to .5 months (11 business days). Although, the change in the number of days it takes to complete the correction-verification cycle is statistically significant with p=0.047, $F_{(observed)}$ = 3.313, this goal was not met. Based on Figure 9 and Figure 10, the 11 business day cycle is not a realistic goal for completing the correction-verification cycle. The current correction-verification process' capability is between one and 40 days with the majority (70.8%) of the reports being completed within 16 business days and 87.5% within 25 business days. Comparing Figures 8, 9 and 10, notice the correction-verification cycle began stabilizing in December 2014. December 2014 is pivotal since all changes to the *AccuTrack* correction-verification process were finalized and implemented.

For the fall semesters, cycle times are higher in September and October and in February and March for the spring semesters. This pattern is the same regardless of the number of months in each semester and the number of days in the second month of the semester. These months also have some of the highest sign-in-sign-out error rates (Figure

12). October and March are usually the months when midterms are given at UNI. September and February are the first full months of the fall and spring semesters respectively and is about the time when most students are scheduled to take their first exam. These factors cause the volume of students using the tutoring services to be higher, and the number of first time users to the tutoring center to increase. Thus, impacting the number of sign-in-sign-out errors. Hence, the more errors to correct, the longer the cycle time for the correction-verification process. The box and whisker plot in Figure 11 provides a pictorial comparison of how the mean cycle times changed over the duration of the project.

Reflection

There are some unique aspects of the research environment that could influence the results of this study. The Academic Learning Center has an established culture of working in teams. This may not be common within all learning centers and could impact the level of collaboration that is needed to succeed in a Six Sigma project. Carry-over effect is another limitation. All coordinators and student staff had previous experience, both positive and negative, working with the *AccuTrack* database. Also, the Math and Science Services tutors have previous experience working with a variety of databases and possess foundational technical skills others may not. The majority of the math and science tutoring staff are certified tutors and have multiple years of experience working as tutors and Supplemental Instruction leaders which may be atypical of learning centers. Hence, the tutors did not have to be trained simultaneously on how to use the database while completing the tutor certification training program.

It was assumed that the Academic Learning Center would continue to use the *AccuTrack* database to collect its usage data and that there would be turnover in student staff during the study.

It is recommended that the Academic Learning Center hires an individual dedicated to providing the center technical support. Lack of technical knowledge was one of the critical to quality elements to be addressed during this study. The Six Sigma Team will continue to evaluate and revise the correction-verification process as needed. Phase two of the project is to evaluate the impact of the revised correction-verification process on the cycle time of the remaining five units in the Academic Learning Center.

The Tech Team Chair's knowledge of *AccuTrack* and its capabilities as a tracking system improved. Furthermore, improving the process saved the Academic Learning Center $16,833.84 in 2014-2015 and $2,785.97 in 2015-2016. The amount of time the Tech Team chair spent completing the six usage reports decreased from 40 hours (1 week) per month to eight hours per month. The time the Math Coordinator's spent completing the report specifically from Math and Science Services decreased from eight hours monthly to 4 hours including the one hour per month *AccuTrack* meeting with all coordinators.

Creating the *Access* database did not completely eliminate the need to use the paper Individual Appointment logs, Daily Verification logs, and staff calendars to verify the *AccuTrack* monthly usage reports. There were tutors who forget to input the usage data by the deadline or who made mistakes in entering students' names and ID numbers. Similarly, there are times when students will forget to sign-in and sign-out of the center.

These are the types of student variabilities critics argue that the Malcolm Baldrige Excellence Award does not account for. The power of the Six Sigma process is that it considers and accounts for variability by evaluating a process to find its true capability. We learned from the data collected our goal to complete the *AccuTrack* correction-verification process in 11 business days was unrealistic based on the number of variables that contributed to the success of the process. The Analyze Phase of the DMAIC process brought this to light objectively through the data collected.

Completing the DMAIC process helped us to identify all variables that contribute to the process, but also gave us insight on what to do next. This was the downside of completing the CAST. The CAST brought to light what needed to be addressed in the organization but offered no insight on the variables that need to be considered in order to make improvements or a process for making the needed improvements.

Another powerful aspect of the Six Sigma DMADV and DMAIC methodologies is the ability to take a simple process as counting to help solve complex problems. Many educational institutions collect “count” data—how many students are enrolled, how many receive financial aid, how many graduate within a given time frame, GPA, and ACT/SAT scores, but few institutions know how to leverage this “count” data to help address the critical issues such as financial instability, declining enrollment, underprepared students, and increased enrollment amongst first generation students. Both the DMAIC and DMADV process improvement methods help an organization decide which performance indicators and the corresponding metrics that will be used to measure whether or not the indicator is met. Benjamin, in *The School Quality Rubric and Explanation of Key*

Elements (2007), recommends that before any educational institution undergoes a quality improvement plan that they spend time gather baseline performance measures for each indicator. This process is already built into the Six Sigma model through the Analyze and Measure steps. Also, the reliance on statistical measures and data-driven decision making is what distinguishes Six Sigma from Appreciative Inquiry.

The *Access* database helped to increase the accuracy of the student usage data and allowed us to catalog the department and courses for which students receive tutoring. Scheduling office hours for tutors to input student usage information into the database, allowed them to focus more on meeting the students' academic needs during the tutoring sessions.

Although, there were more steps involved in the revised correction-verification process, it was more efficient as indicated by the decrease in the number of working days and drafts needed to complete the correction-verification process. In addition to this, the Academic Learning Center was able to find a viable solution to the crashing of the *AccuTrack* system. This success was due to every customer or stakeholder being brought into the process to provide their expertise and insight on what should be done.

This team approach to process improvement is prevalent in every phase of the Six Sigma DMAIC and DMADV methods. Consistently listening to and taking into consideration the voice of all stakeholders created an atmosphere of collaboration, trust, and broke down silos that existed between the different units. Having an established consistent methodology that was followed by everyone also dismantled the politics often associated with problem solving and allowed the team to realize that each member would benefit once the problem was solved. When this was realized communication improved amongst the coordinators, between the Tech Team and the coordinators, and between the Tech Team Chair and the *AccuTrack* technical support staff.

Critics of the continuous improvement approach to evaluating educational quality resist Six Sigma and other process improvement methods because they do not view students as customers and education as a good to be traded. However, what these critics fail to realize is that the business sector has a long history of overcoming obstacles such as budget shortfalls, customer dissatisfaction, low morale, and public distrust that educators must now tackle. In addition, educational assessment has become more complicated, and educational institutions have more partners to whom they are accountable. The business sector from their years of experience have developed methodologies that have helped them structure, track, and evaluate the various data they collect from their customers, suppliers, and other constituents. Using these quality processes such as Six Sigma have helped businesses to be successful and remain accountable to their stakeholders. Research on AQIP, the Baldrige Award, balanced scoreboard, Appreciative Inquiry, and Six Sigma illustrate that these process improvement tools, although developed in and for business and industry, can be successfully used in the education sector. When these tools are used they provide objective methods in which to document and solve problems.

Conclusion

This research provides a foundational framework for how learning centers can apply the Six Sigma Define, Measure, Analyze, Design, Verify (DMADV) and Define, Measure, Analyze, Improve, Control (DMAIC) methodologies to improve processes related to service delivery to students, improve efficiency, improve communication and build collaboration amongst staff members, and improve productivity of staff. The Six Sigma methodologies worked because the team's focus was on solving the problem. Having data helped to identify problems in the process instead of faulting the staff who were executing the correction-verification process and helped the team to make objective data-driven decisions. The process was also effective because it allowed for thorough critique and consensus of solutions before they were implemented. This ensured autonomy in the decision process and helped to equalize power amongst individuals of varying leadership in the department.

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APPENDIX A

AccuTrack REPORTS MONTHLY MEETING SCHEDULE

AccuTrack Reports
Monthly Meeting Schedule

The following is a schedule for meeting with the Tech Team member to coordinate monthly *AccuTrack* reporting.

For each month:

- the first date listed is the date by which Tech Team member will get the draft reports to each coordinator. (In most cases this will be the first Friday of the month.)
- the second is the date by which the coordinators will meet as a group to discuss revisions.
- the third date is the date by which the scheduled coordinator will meet with the Tech Team member to go through a consolidated list of changes.

	Fall 2014		**Spring 2015**		
	Staff Name	**Date**	**Staff Name**	**Date**	
July	**SSS Coordinator**	8/8	**SSS Coordinator**	2/6	**January**
		8/13		2/11	
		8/15		2/13	
August	**MASS Coordinator**	9/5	**MASS Coordinator**	3/6	**February**
		9/10		3/11	
		9/12		3/13	
September	**CRLC Coordinator**	10/3	**CRLC Coordinator**	4/3	**March**
		10/8		4/8	
		10/10		4/10	
October	**AARS Coordinator**	11/7	**AARS Coordinator**	5/8	**April**
		11/12		5/13	
		11/14		5/15	
November	**WC Coordinator**	12/5	**WC Coordinator**	6/5	**May**
		12/10		6/10	
		12/12		6/12	
December	**Testing Coordinator**	1/9		7/2 or 6	**June**
		1/14		7/8	
		1/16		7/10	

APPENDIX B

AccuTrack CHANGE FORM

AccuTrack
Change Form

Name ______________________________

First **Last**

ID# ______________________________

INFORMATION AS IT SHOULD BE:

Date ______________________________

Signed in at: ______________________

Signed out at: ______________________

Tutor
name: ____________________________

REASON FOR CHANGE:

____

____

____

Submitted by: ____________________________

Please place this form in Kathy's mailbox located behind the secretary in room 008.

APPENDIX C

AccuTrack CORRECTION-VERIFICATION CYCLE DATA

Month-Year	Date of First Draft	Date of Final (Correct) Report	Number of Business Days in Cycle	Number of Drafts in Cycle	Primary Errors (Draft 1)	Total Number of Errors
Aug-13	2/26/2014	5/22/2014	62	No data	13	13
Sep-13	10/8/2013	12/16/2013	48	3	0	0
Oct-13	11/19/2013	4/21/2014	105	4	1	3
Nov-13	12/4/2013	5/22/2013	121	3	24	79
Dec-13	1/3/2014	5/9/2014	92	3	1	8
Jan-14	2/13/2014	3/3/2014	13	2	21	21
Feb-14	3/6/2014	4/21/2014	32	3	40	41
Mar-14	4/7/2014	4/21/2014	11	No data	45	45
Apr-14	5/1/2014	5/22/2014	16	3	21	24
May-14	6/2/2014	6/6/2014	5	2	12	12
Jun-14	7/2/2014	7/18/2014	13	3	54	56
Jul-14	8/1/2014	8/11/2014	6	5	25	30
Aug-14	9/5/14	11/15/14	51	6	22	29
Sep-14	10/24/14	4/12/15	115	7	1	158
Oct-14	11/7/14	4/12/15	110	4	1	108
Nov-14	12/1/14	4/12/15	92	4	57	78
Dec-14	1/14/15	2/24/15	29	4	1	39
Jan-15	2/9/15	4/20/15	30	4	41	43

Month-Year	Date of First Draft	Date of Final (Correct) Report	Number of Business Days in Cycle	Number of Drafts in Cycle	Primary Errors (Draft 1)	Total Number of Errors
Feb-15	3/31/15	4/14/15	31	3	83	84
Mar-15	4/13/15	4/22/15	13	3	60	61
Apr-15	5/12/15	5/19/15	6	3	40	46
May-15	5/29/15	6/5/15	6	4	12	18
Jun-15	7/1/15	7/13/15	8	2	5	5
Jul-15	8/4/15	8/7/15	4	1	0	0
Aug-15	9/2/15	9/14/15	9	2	13	13
Sep-15	10/1/15	10/30/15	22	2	42	42
Oct-15	11/5/15	12/1/15	15	2	47	47
Nov-15	12/1/15	12/14/15	10	2	40	40
Dec-15	12/22/15	1/9/16	11	2	17	17
Jan-16	2/1/16	2/22/16	16	2	11	11
Feb-16	3/1/16	3/21/16	15	2	16	16
Mar-16	4/2/16	5/1/16	23	2	24	24
Apr-16	4/30/16	5/16/16	11	2	15	15
May-16	5/31/16	6/20/16	14	2	13	13
Jun-16	6/30/16	7/18/16	12	2	4	4
Jul-16	8/5/16	8/21/16	11	2	1	1
Aug-16	9/2/16	9/26/16	17	3	18	20
Sep-16	10/1/16	11/14/16	30	2	30	55
Oct-16	11/1/16	12/201/16	27	2	72	72
Nov-16	12/1/16	12/20/16	14	2	35	35
Dec-16	12/19/16	1/21/17	24	2	31	31

APPENDIX D

ANOVA TABLES

Descriptives								
AccuTrack Errors								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Pre-Process 2013-2014	12	27.8333	23.53656	6.79442	12.8789	42.7878	2.00	79.00
Phase I 2014-2005	12	55.7500	45.59530	13.16223	26.7801	84.7199	.00	158.00
Phase II 2015-2016	17	26.8235	19.29778	4.68040	16.9015	36.7455	1.00	72.00
Total	41	35.5854	32.33649	5.05011	25.3787	45.7920	.00	158.00

ANOVA					
AccuTrack Errors					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6905.564	2	3452.782	3.757	.032
Within Groups	34920.387	38	918.958		
Total	41825.951	40			

Descriptives Numbers of Drafts in Cycle								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Min	Max
Pre-Process 2013-2014	10	3.10	.876	.277	2.47	3.73	2	5
Phase I 2014-2005	12	3.75	1.603	.463	2.73	4.77	1	7
Phase II 2015-2016	17	2.06	.243	.059	1.93	2.18	2	3
Total	39	2.85	1.226	.196	2.45	3.24	1	7

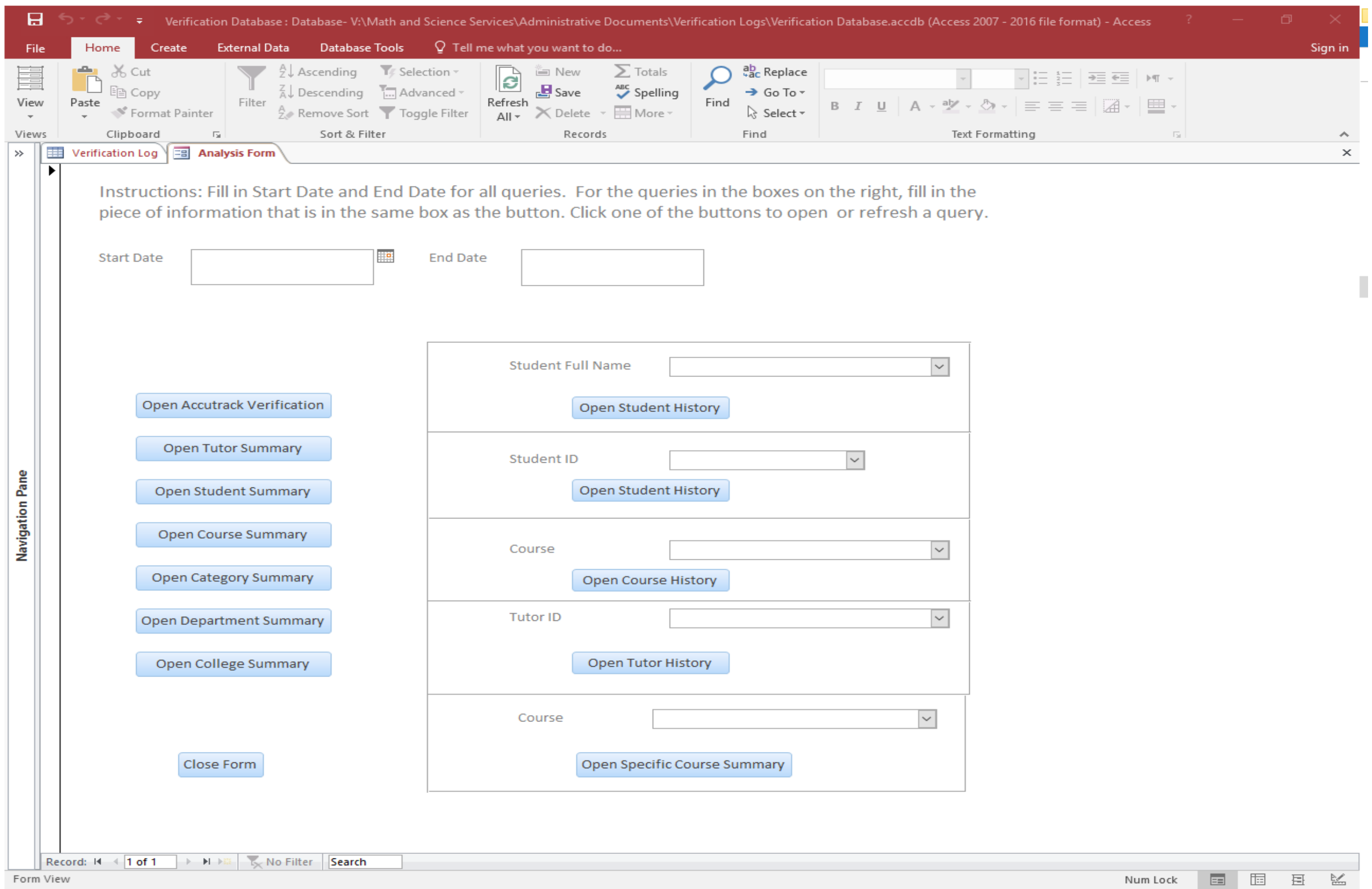
ANOVA					
Number of Drafts in Cycle					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	20.986	2	10.493	10.466	.000
Within Groups	36.091	36	1.003		
Total	57.077	38			

Descriptives *AccuTrack* Cycle Time in Number Business Days								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Pre-Process 2013-2014	12	43.6667	41.77501	12.05941	17.1241	70.2092	5.00	121.00
Phase I 2014-2005	12	41.4167	41.50456	11.98134	15.0459	67.7874	4.00	115.00
Phase II 2015-2016	17	16.5294	6.36512	1.54377	13.2568	19.8021	9.00	30.00
Total	41	31.7561	33.74817	5.27058	21.1039	42.4083	4.00	121.00

ANOVA *AccuTrack* Cycle Time in Number Business Days					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6763.742	2	3381.871	3.313	.047
Within Groups	38793.819	38	1020.890		
Total	45557.561	40			

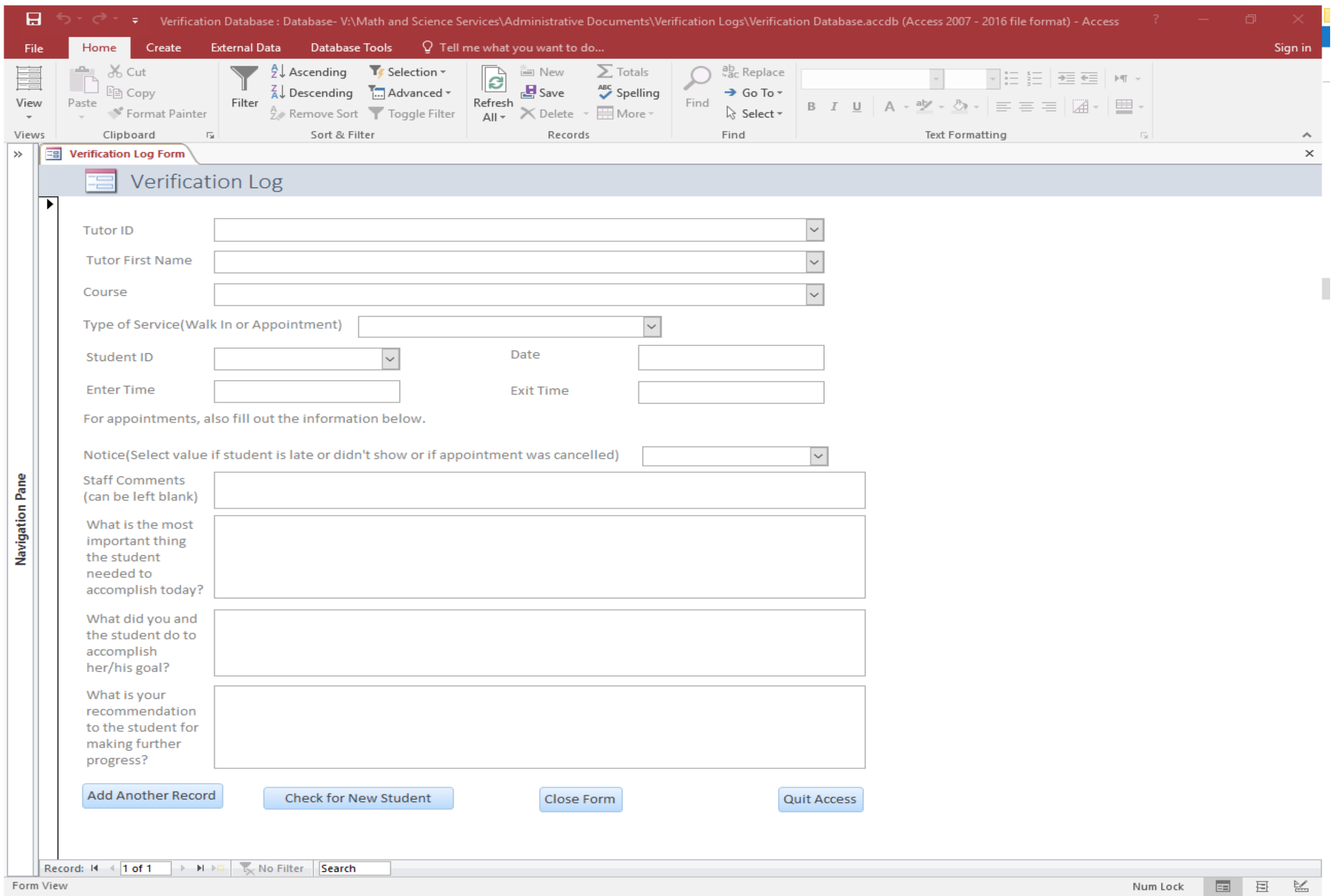
APPENDIX E

MASS *Access* DATABASE ANALYSIS FORM



APPENDIX F

MASS *Access* DATABASE VERIFICATION LOG FORM



APPENDIX G

MASS *Access* DATABASE ERROR DATA

Initial Report Date	Final Report	Month -Year	Number of Drafts in Cycle	Total Number of Errors	Entries Not In Database	Incorrect Draft	Other
10/24/14	4/12/15	Sep-14	7	67	66	1	0
11/7/14	4/12/15	Oct-14	4	111	41	1	69
12/1/14	4/12/15	Nov-14	4	25	11	0	14
1/14/15	2/24/15	Dec-14	4	37	35	2	0
2/9/15	4/20/15	Jan-15	4	6	5	1	0
3/31/15	4/14/15	Feb-15	3	6	6	0	0
4/13/15	4/22/15	Mar-15	3	15	15	0	0
5/12/15	5/19/15	Apr-15	3	14	12	0	2
5/29/15	6/5/15	May-15	4	4	4	0	0
7/1/15	7/13/15	Jun-15	2	0	0	0	0
8/4/15	8/7/15	Jul-15	1	0	0	0	0
9/2/15	9/14/15	Aug-15	2	4	1	0	3
10/1/15	10/30/15	Sep-15	2	1	1	0	0
11/5/15	12/1/15	Oct-15	2	2	2	0	0
12/1/15	12/14/15	Nov-15	2	3	3	0	0
12/22/15	1/9/16	Dec-15	2	20	1	0	19
2/1/16	2/22/16	Jan-16	2	6	6	0	0
3/1/16	3/21/16	Feb-16	2	0	0	0	0
4/2/16	5/1/16	Mar-16	2	2	2	0	0
4/30/16	5/16/16	Apr-16	2	7	4	0	3
5/31/16	6/20/16	May-16	2	12	9	0	3
6/30/16	7/18/16	Jun-16	2	3	3	0	0
8/5/16	8/21/16	Jul-16	2	0	0	0	0
9/2/16	9/26/16	Aug-16	3	5	5	0	0
10/1/16	11/14/16	Sep-16	2	32	32	0	0
11/1/16	12/201/16	Oct-16	2	14	13	0	1
12/1/16	12/20/16	Nov-16	2	23	22	0	1
12/19/16	1/21/17	Dec-16	2	10	10	0	0

APPENDIX H

MASS INDIVIDUAL APPOINTMENT CONSULTATION LOG

Please have the student enter their demographic information below. Check to make sure the course name is the official University course name.

Name:____

Student #____

Telephone#:____

Email:____

Official University Course Name:____

Date and Time	**Staff Initial**	**What is the most important thing the student needed to accomplish?**	**What did you and the student do to accomplish her/his goal?**	**What is your recommendation to the student for making further progress?**	**Database entry date staff initial**

APPENDIX I

TUKEY HSD

Tukey HSD Multiple Comparisons						
Multiple Comparisons Dependent Variable: *AccuTrack* Errors						
					95% Confidence Interval	
(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Pre-Process 2013-2014	Phase I	-27.91667	12.60034	.083	-58.8353	3.0020
	Phase II	7.58333	12.60034	.820	-23.3353	38.5020
Phase I 2014-2015	Pre-Process	27.91667	12.60034	.083	-3.0020	58.8353
	Phase II	35.50000*	12.60034	.022	4.5814	66.4186
Phase II 2015-2016	Pre-Process	-7.58333	12.60034	.820	-38.5020	23.3353
	Phase I	-35.50000*	12.60034	.022	-66.4186	-4.5814
*. The mean difference significant at the 0.05 level.						

Tukey HSD Multiple Comparisons							
Dependent Variable: *AccuTrack* Cycle Time							
Dependent Variable	(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
AccuTrack Cycle Time	Pre-Process 2013-2014	Phase I	2.25000	13.04409	.984	-29.5623	34.0623
		Phase II	27.13725	12.04685	.075	-2.2429	56.5174
	Phase I 2014-2015	Pre-Process	-2.25000	13.04409	.984	-34.0623	29.5623
		Phase II	24.88725	12.04685	.111	-4.4929	54.2674
	Phase II 2015-2016	Pre-Process	-27.13725	12.04685	.075	-56.5174	2.2429
		Phase I	-24.88725	12.04685	.111	-54.2674	4.4929

APPENDIX J

AccuTrack CORRECTION-VERIFICATION TIME LINE

SUMMER 2014	FALL 2014	SPRING 2015	SUMMER 2015
Define, Measure, Analyze, and Design Phases	**Design and Verify Phases**	**Control Phase**	***Re*-Design, Measure, Analyze, Improve, Control Phases**
-Document *AccuTrack* errors -Coordinator meetings -Revamp correction-verification process -Develop Correction-Deletion Form -Hire graduate student	-Document *AccuTrack* errors -Revise Correction-Deletion Form - Develop documentation -Implement new correction-verification process -Develop second corrections verification process	-Develop documentation -Document *AccuTrack* errors -Full use of MASS *Access* database in correction-verification process -Track number of days, types of errors and number of drafts -New server for *AccuTrack*	-Develop/Revise documentation -Control sign-in-sign-out structure for MASS - Improve MASS database queries -Collect data on cycle time and errors -Continue verifying and controlling processes

APPENDIX K

MASS *Access* DATABASE DEVELOPMENT TIME LINE

SUMMER/FALL 2014	SPRING 2015	SUMMER 2015	FALL 2015	SPRING 2016-
Define, Measure, Analyze, Design, and Verify Phases -Create *Access* database -Test and redesign database -Train staff -Pilot Testing -Correct design flaws -Develop documentation -Track number of days and documents used to verify *AccuTrack* usage report	**Control and Design Phases** -Capability study with all staff -Correct design flaws -Develop documentation -Track number of days and documents used to verify *AccuTrack* usage report	***Re*-Design, Measure, Analyze, Improve, Control Phases** -Develop/Revise documentation -Develop new *AccuTrack* sign-in-sign-out structure MASS - Redesign MASS database -Collect data on cycle time and errors -Control correction-verification process	***Re*-Design, Measure, Analyze, Improve, and Control Phases** -Limited testing MASS database -Control *AccuTrack* correction-verification process -Collect error data for MASS database and *AccuTrack*	**Measure, Analyze, Improve, and Control Phases** -Full use of MASS database -Control *AccuTrack* correction-verification process -Make improvements where necessary to MASS *Access* database -Collect error data for MASS database and *AccuTrack* -Revise documentation