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Building bridges: connecting collegiate athletic and mathematics culture

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BULIDING BRIDGES: CONNECTING COLLEGIATE ATHLETIC AND MATHEMATICS CULTURES

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ABSTRACT

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Student-athletes serve as ambassador of their respective universities through both their academic and athletic experiences. These experiences distinguish student-athletes from their non-athlete counterparts, and has given rise to the current distinct student-athlete culture that exists within colleges and universities nationwide. This phenomenological study served as initial exploratory research investigating the nature of the culture of collegiate student-athletes in relationship to the culture of mathematics at a Division I public university in the western United States having an approximate enrollment of 13,000 students. The sample involved 10 student-athletes, four members of the mathematics faculty, four members of the athletic department staff, and two members of the Athletic Planning Committee. Data included semi-structured interviews, observations of four mathematics classes, and observations of the athletic department's Academic Support Services. Data analysis was conducted in two phases, a thematic development of student-athlete and mathematics faculty interview data through constant comparison, followed by analytic induction using athletic department staff interview and observation data. Findings from the analysis suggested student-athletes' engagement and perception of mathematics may be influenced by their mathematics education experience, support systems, authority figures, and career goals. Furthermore, the findings give evidence of disconnect between two members of the mathematics faculty's perception of mathematics and the mathematics they presented through their teaching. This disconnect may also have an effect on student-athletes' perception of mathematics. The discussion includes potential implications of the study in regards to student-athletes' mathematics education, as well as to how mathematics faculty portrays mathematics in their instructional practice.

Keywords: mathematics, student-athletes, culture, undergraduate, perception, engagement, qualitative

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CHAPTER I

INTRODUCTION

Student-athletes serve as ambassadors for their respective universities through both their academic and athletic accomplishments. The responsibility of being ambassadors of their schools places pressure on student-athletes to be successful on the field and in the classroom. Student-athletes' athletic endeavors serve to develop a sense of camaraderie among students, faculty, and the local community. Success on the field generates a sense of pride and accomplishment within the community and raises the profile of the student-athletes' educational institution (Gerdy, 2006). Thus, the community becomes emotionally invested in student-athletes' athletic accomplishments. This investment can result in the community focusing on only student-athletes' athletic endeavors, ignoring student-athletes' academic responsibilities and identity. The loss of focus on student-athletes' academic endeavors has not gone unnoticed. Myles Brand, the late president of the National Collegiate Athletic Association (NCAA), addressed the lack of current research focusing on the academic identity and experience of collegiate student-athletes at the 2008 colloquium, *College Sports: A Legitimate Focus for Scholarly Inquiry?* He commented that this deficiency in research focusing on student-athletes provided of the academic community's lack of concern for student-athletes education (Powers, 2008). To promote issues surrounding student-athletes' education the NCAA has encouraged members of academia across a broad range of disciplines to conduct research concentrating on improving student-athletes' education to aid in generating awareness and interest in student-athletes' academic identity within the academic community (Powers, 2008).

The goal of improving students' education is at the core of research in mathematics education. Schoenfeld (2000) suggested the purpose of research in mathematics education is to develop an understanding of the nature of mathematical thinking, teaching and learning, and apply this understanding to improve the teaching of mathematics. It is important that mathematics educators fulfill their responsibility of providing students with a quality education. As mathematics educators, it is part of our obligations to provide all students with equal opportunities and resources necessary to learn mathematics (National Council of Teachers of Mathematics [NCTM], 2000). Not only do we want to provide students the opportunity to learn mathematics, but we also desire to have students develop sense for the underlying beauty or connections within mathematics. While these aspirations are noble, assisting in the development of students' understanding of mathematical content and the beauty of mathematics, they may appear rather shallow in students' overall collegiate education. Therefore, there is a need to focus on the importance of mathematics in higher education for improving students' overall education.

Required mathematics courses have shown to impact students' performance in subsequent classes as well. Herzig (2005) argued that students who did not have a solid mathematical foundation would find it more difficult to be successful in prerequisite mathematics courses, and hence students' choices regarding their higher education would become significantly limited. Green, Stone, Zegeye, and Charles (2007) studied the effects of a College of Business's, at a large Midwestern university, decision to lower the mathematics prerequisites needed for admission into the business school. The College of Business found with the reduced mathematics requirements that students were enrolling in business school at a far greater rate than previous years. The authors examined how these new requirements impacted students' success in their later business courses. Green, et al. found that students' performances in business courses, particularly business statistics, were negatively impacted by the College of Business's loosened mathematics requirements. This conclusion is supported by the work of Pozo and Stull (2006). Pozo and Stull found that the requirement of a mathematics course increases students' effort in school and students' academic performance by two percentage points. Furthermore, the authors found that lower achieving students were the most affected by their participation in required mathematics courses. Pozo and Stull noted that this improvement could be an indication that students participating in remedial mathematics are receiving the assistance they need. While students' academic performance was shown to improve with their participation in remedial mathematics courses, their enrollment in remedial mathematics course was shown as contributing factor in reducing students' odds of second-year retention. Generally these remedial mathematics courses are designed to develop students’ mathematical skills, particularly in algebra. Thus, Pozo's and Stull's findings are reflected in the work of Adelman (1999). Adelman suggested that students' secondary school mathematics background was critical in students' collegiate academic success. Students' who completed courses above Algebra II in high school were found to be more than twice as likely to complete their bachelor’s degree as those who did not. Lesik (2007) argued that students participating in developmental mathematics courses designed to allow students to learn mathematics they were supposed to learn in high school improves student retention by establishing a connection between the students and the school. It is important to note that Lesik described developmental courses as offering higher level of mathematics than that offered in remedial courses.

Participation in mathematics has not only shown to improve students' academic performance, but majoring in a field that requires higher-level mathematics and passing a first-year mathematics course have also shown to increase the chance that students will return for a second year of college. Herzog (2005) investigated challenges and patterns in freshmen retention at public research universities by examining measures of high school preparation, first-year academic performance, multi-institution enrollment, and financial aid support on second-year enrollment. The author found that students entering into majors that required the completion of higher level mathematics courses were found to be more persistent in remaining in college than their counterparts whose coursework did not require a significant amount of mathematics. Herzog reported that not only pursuing a mathematically intense major reduced students' chances of transferring or dropping out of college, but students' academic success in their first-year mathematics course was one of the major factors in predicting students' retention at the college level. Additionally, students that avoided enrolling in mathematics courses during their first year of college were shown to be five times more likely to transfer or dropout of college.

Improving students' mathematics education and engagement with mathematics can result in the improvement of students' overall education as well. Unfortunately, there was a lack of literature focusing on student-athletes' engagement with mathematics and advancing student-athletes' mathematics education. Thus, there was a need to look to other research for inspiration and direction for to examine student-athletes' mathematics education.

Many mathematics education researchers have attempted to advance students' mathematics education by exploring the effects students' identity and culture have on students' relationship with mathematics (Civil, 2002; Lerman, 2001; Malloy & Malloy, 1998; Stigler & Barnes, 1988; Stinson, 2006). However, most of this research was restricted to defining students' identity and culture though students' gender, ethnicity or socio-economic status (Civil, 2002; Hyde & Mertz, 2009; Ladson-Billings, 1997; Walker, 2006). This constraint can omit unique cultures that arise from the roles and identities students possess within an educational institution.

Tillman (2002) defined culture as “a group’s individual and collective ways of thinking, believing, and knowing, which includes their shared experiences, consciousness, skills, values, forms of expression, social institutions, and behaviors” (p. 4). Tillman’s definition refrained from defining a culture by gender, ethnic, or socio-economic traits, but instead focused on classifying culture as a collective group of individuals that share common experiences and ways of thinking. While Tillman’s definition allows for one to consider groups of individuals sharing gender, ethnic, and socio-economic traits as cultures, it also allows one to consider cultures defined by other shared experiences and characteristics. There was a desire among researchers (Hu & Kuh, 2003a; Pascarella, 2006) for an increase in research focusing on the experiences and interactions of cultures defined by characteristics other than race or ethnicity.

Student-athletes’ athletic endeavors places them in a unique role within their college communities. This role presents student-athletes with many experiences during their transition to college and overall college tenure that the general student population will rarely encounter. It was student-athletes’ distinguishing academic and athletic experiences that gave rise to the student-athlete culture that existed within colleges and universities nationwide (Gerdy, 2006; Kissinger & Miller, 2009). Bell (2009) suggested that student-athletes have become isolated from the general student population; thus, making it difficult for student-athletes to even develop relationships with non-athlete students.

Pascarella (2006) suggested that students' experience with diverse populations, and not simply racial or ethnically diverse populations, improve the intellectual and personal impacts of college. The author went on to explain the importance for students to have these diverse experiences both inside and outside of the classroom setting. Exposure to different people, ideas, beliefs, and world views force students to reflect their own perspectives, and promotes individual growth. Hu and Kuh (2003a) explained that encouraging students to interact with others from diverse backgrounds will have positive effects on all those involved with the interaction. These positive effects were found to be directly related to students’ participation in diverse experiences. Students’ academic and social experiences help connect them to others with different perspectives and knowledge constructed through unique prior experiences. Hu and Kuh suggested that students’ involvement with diverse cultures and experiences prepare students to live and work with others in a cooperative diverse society, improve students’ intellectual development, increase gains in students’ learning, and help students examine their own role in society. There was a need to examine student-athletes' cultural relationships to increase the educational diversity and strengthen the overall education of the student-athlete population.

Developing an understanding of student-athletes' cultural relationship with the mathematics culture will help inform educators on how to improve student-athletes' mathematics education and engagement with mathematics. Increasing the amount of interaction between student-athletes and the mathematics community, or increasing the number of student-athletes within the mathematics community, will aid in diversifying student-athletes' educational experiences and diversifying the student-athlete population. This increased diversification can help improve student-athletes' overall education (Hu & Ku, 2003a; Pascarella, 2006).

This research served to address the deficiency in literature regarding the relationship between the culture of student-athletes and mathematics culture. Analyzing the relationship between student-athletes’ and the mathematics culture within a university offered many benefits to both the athlete and the educational institution. Understanding student-athletes’ concerns surrounding mathematics can provide institutions an outline to actively engage student-athletes to enrich their mathematical experiences. The process of student-athletes discussing their academic concerns may not only serve as a stress reliever, but it may also spark student-athletes to take an interest and invest in their own education (Whitner & Meyers, 1986). This dialogue can also help the student to address their academic and athletic demands.

While there was a significant amount of literature that focused on the impacts of institution-sponsored collegiate athletics on higher education (Clotfelter, 2011; Gerdy, 2006; Lapchick, 2006; Sperber, 2001; Thelin, 1996; Yost, 2010), the goal of this research is not to bring about overarching academic reform for collegiate athletes. Instead, the aim is to inform mathematics faculty, members of the athletic department, and student-athletes of the cultural relationship between student-athletes and mathematics departments at Division I colleges and universities, and how this relationship may affect student-athletes perception and participation with mathematics. Thus, allowing the individuals, whom possess the greatest opportunity to influence student-athletes' mathematical education, the ability to make informed decisions during their interactions with student-athletes. This can assist educators in fulfilling their responsibility to provide all students equal opportunities and resources necessary to learn mathematics (NCTM, 2000). Additionally, it was the hope of the researcher that this study will encourage further research into the culture of student-athletes’ relationship with other subjects besides mathematics to increase the educational diversity and strengthen the overall education of the student-athlete population.

The outline of the research problem and significance of the study may give the reader pause to consider the research’s relevance in the field of mathematics education. This is a fair concern. However, if mathematics researchers and educators desire to see a particular subpopulation of the collegiate student body become engaged with mathematics then we, the members of the mathematics community, must be willing to commit our resources to research how this student subpopulation interacts with the mathematics culture and how we may encourage these students to become involved in the mathematical community. No other group has the direct incentive to invest the time and energy to research and promote the mathematics community’s values to members of the student population. Through the investment of researching the culture of collegiate student-athletes relationship to the culture of mathematics, the researcher hoped to build a broader base for encouraging students to become involved members of the mathematics community, and thus aid in preserving the mathematical community by ensuring that it maintains a sustainable number of members. Furthermore, Herzig (2002) argued the need for research into issues involving the interaction, participation, and integration of students in the mathematics community at various educational levels and types of institutions.

Research Question

Q1 How do perceptions and the relationship between the culture of collegiate student-athletes and the culture of mathematics develop at a Division I university?

Q2 Does student-athletes' identity, authority figures, career goals, support systems, and mathematics education influence their attitude, interest, and/or motivation to participate in or becoming involved with the culture of mathematics?

Definition of Terms

This study examined the student-athlete and mathematics cultures at the collegiate level and the relationship between the two cultures. Thus, the following terms were defined:

Student-Athlete – individuals who participate in university or college sponsored varsity sports programs.

Mathematics Community – includes individuals who engage in promoting, teaching, or working in the field or relating to the field of mathematics. (e.g. Mathematicians, graduate students, mathematics teachers, statisticians, physicists, etc.)

Mathematics Culture –the mathematics community's individual and shared experiences, skills, values, forms of expressions, and social institutions that are rooted in mathematics. These individual and collective ways of thinking, believing, and knowing are evident in the mathematics community's interaction with mathematical content, other members of the mathematics community, and with those engaged in learning mathematics.

Division I Program – include schools that offer at least 14 sports programs, which at least half are women's teams. Of these 14 sports, two must be for each gender. The institution must have teams participating in the fall, winter, and spring seasons. These Division I colleges and universities must offer a minimum amount of financial aid to student-athletes. However, this financial aid cannot be higher than an NCAA set amount (NCAA, 2011).

Authority Figures – include a student-athlete's coaches, parents and teachers (Bell, 2009; Delaney & Madigan, 2009; Johnson, 1985; Papanikolaou, Nikolaidis, Patsiaouras, & Alexopoulos, 2003; Simons, Bosworth, Fujita, & Jensen, 2007).

Career Goals - relate to a student-athlete's desired career upon graduation (Delaney & Madigan, 2009; *Life After Sports*, 2007).

Mathematics Education Experiences – involve a student-athlete's successes and tribulations while taking mathematics courses (Delaney & Madigan, 2009; Hannula, 2002; Middleton & Spanias, 1999; Schiefele & Csikszentmihalyi, 1995).

Support System – includes influence from a student-athlete's peers, teammates and other supporting personnel as it relates to mathematics (Bell, 2009; Delaney & Madigan, 2009; Koller, Baumert, & Schnabel, 2001; Marx, Huffmon, & Doyle, 2008; Whitner, 1986).

Mathematical Course Experience – the student-athlete were categorized into three groups based on the amount and type of mathematics courses they have completed. Mathematics-related courses were taken into account as part of their mathematical experiences, since the student-athletes needed to access certain aspects of mathematical knowledge to be successful in these courses.

Below the three categories are defined:

Low Amount of Mathematical Experience – Students whose mathematics coursework consists of no mathematics course higher than pre-calculus. Their other mathematics-related courses require no mathematical prerequisites higher than pre-Calculus.

Moderate Amount of Mathematical Experience – students whose mathematics coursework consists of mathematics courses from a strong pre-Calculus background through differential equations. Their mathematics-related courses require mathematical prerequisites higher than college algebra.

High Amount of Mathematical Experience – students whose mathematics coursework consists of mathematics courses higher than differential equations or includes at least one proof-based mathematics course. Their mathematics-related courses require mathematical prerequisites higher than Calculus II.

Delimitations

This research possessed the inherit delimitations from the sample of student-athlete participants involved in this study being restricted to be student-athletes participating in varsity sport programs that were affiliated with a single university selected from the western region of the United States. Therefore, the delimitations included the following: (1) participants were college age adults, ranging from 18-25 years of age, (2) participants were included on the official roster in their respective sport, and (3) participants were full-time students, registered for at least 12 course credit hours during the semester.

There also existed delimitations from the sample of academic faculty involved in this study being restricted to be mathematics faculty and graduate teaching assistants that were members of a mathematics department at a single university selected from the western region of the United States. Therefore, the delimitations included the following: (1) faculty participants and some graduate teaching assistant participants possessed at least a master's degree in mathematics, applied mathematics, or mathematics education, (2) some graduate teaching assistant participants were in the process of earning a master's degree in mathematics or applied mathematics, (3) participants were instructors of record for a mathematics course.

Delimitation was inherent in the restriction sample of athletic department staff to those persons employed by an athletic department at a single university selected from the western region of the United States.

Limitations

The method of sampling student-athletes created a limitation in the research since its function did not allow for randomness. Asking every varsity student-athlete to participate in this study did not compensate for the probability that only student-athletes actively involved in their education volunteered. This limited the ability to generalize the results of the research.

The sampling method for mathematics faculty and athletic department staff prohibited randomness as well. Asking every mathematics faculty member and athletic department staff member to participate in this study did not address the probability that only faculty and staff interested in student-athletes involvement in mathematics volunteered. This limited the ability to generalize the results of the research.

Additional limitations stemmed from the nature of qualitative research and interview process. The participant may not have been entirely truthful and forthcoming with their responses due to the presence of the interviewer. The ability for the participant and interviewer to communicate effectively with one another also factored into the quality and accuracy of the data collected. Filtering this information through both conscious and unconscious subjective interpretations of the researcher influenced the results of this study.

Dissemination of Findings

The study findings were disseminated in three ways. First, this dissertation was completed as part of doctoral degree requirements and made available to the public through the University of Northern Colorado's library. Second, findings related to how the mathematics faculty's shared their understanding of the mathematics culture was presented at the 2014 Mathematics Association of America Rocky Mountain Section meeting. Finally, the synthesized findings of the study will be sectioned into a series of scholarly articles and submitted to a peer-reviewed mathematics education journal, intercollegiate athletics journal, and higher education student development journal. The intended audience of the dissertation and research presentations was primarily those who have the greatest opportunity to impact student-athletes' mathematics education, including mathematics professors and athletic department staff, but also included educational researchers, student-athletes, and those interested in the mathematics education of student-athletes.

Organization of Research

This research is organized into five chapters. Chapter One provides an introduction to the research: the research problem, the background and reasoning for the research, significance of the research, purpose of research, research questions, definitions of constructs studied, research design, sample studied, data analysis, and delimitations and limitations of the research.

Chapter Two offers a review of literature relevant to the research. This chapter expands upon the research problem, issues surrounding the culture of student-athletes, gives insight into the mathematics culture, and how students interact with the mathematics culture.

Chapter Three details the methodology and procedure for the research. This chapter introduces the research design, and describes the research instruments, data collection, and research participants. The chapter finishes with an assessment of the trustworthiness of the research and description of the research's data analysis procedure.

Chapter Four continues by focusing on the results of the study. This chapter is divided into two main sections: (1) student-athlete culture and (2) mathematics culture. Each section explores factors that contribute to the relationship between the student-athlete and mathematics cultures. Within the student-athlete culture, student-athletes' perception and experiences with mathematics were examined. Special emphasis is given to the research constructs of student-athletes' identity, mathematics education experiences, support systems, authority figures, and career goals. The section on the mathematics culture constructs a description of the mathematics culture present within the university, and how this culture perceives its relationship with students, in particular student-athletes, on campus.

Chapter Five provides a discussion of the research and findings. This chapter provides an overview of the research findings, touching on the significance and goals of the study. Also included is a summary of the methodology and synthesis findings from the research. The chapter ends by exploring the limitations, implications, and recommendations for future research relating to the framework and findings of the study.

CHAPTER II

LITERATURE REVIEW

Before examining the relationship between student-athletes' culture and mathematics culture, it was necessary to build an understanding of a number of diverse topics and issues. First, there was a need to clarify and expand on the definition of culture adopted for this research. The literature demonstrated the importance of culture within mathematics education. This foundation of the study allowed for the development of conceptual understanding of the collegiate student-athlete culture from the literature. In order to develop this understanding, it was necessary delve into the history of student-athletes and explore student-athletes' academic and athletic identities.

The purpose of the research was to investigate the culture of collegiate student-athletes in relationship to the culture of mathematics at a Division I university. Therefore, in addition to understanding the student-athlete culture there was a need to also understand student-athletes' relationship with the mathematics culture. As discussed earlier, there was a deficiency in literature exploring student-athletes' relationship with mathematics culture. Thus, to account for the lack of prior research, it was necessary to develop an understanding of the general student population's relationship with mathematics culture by making use of literature related to students' perception of mathematics, relationships with mathematics instructors, and relationships with peers in mathematics courses. This knowledge of students' relationship with mathematics culture contributed to the awareness of student-athletes' relationship with mathematics culture, and set the groundwork for a conceptual understanding of the relationship between student-athletes' culture and mathematics culture. The conceptual understanding of this relationship served to inform the methods for gathering and analyzing data as this relationship was examined in further depth.

Culture

To begin understanding student-athlete culture and mathematics culture it was necessary to describe the definition of culture adopted for this study. Tillman (2002) defined culture as “a group’s individual and collective ways of thinking, believing, and knowing, which includes their shared experiences, consciousness, skills, values, forms of expression, social institutions, and behaviors” (p. 4). Therefore, in this investigation of the culture of collegiate student-athletes’ relationship to the culture of mathematics at a Division I university it was necessary to gain an understanding of the characteristics of both student-athlete and mathematics cultures, such as how they perceive and construct their identities and how outsiders perceive their identities. Exploring the interactions of each culture has with other members of the community, as well as with those outside of the community, aided in the understanding of the cultures.

Why Consider Student-Athletes as Culture?

As previously documented, culture was a prevalent issue within mathematics education. Therefore, the question became, “Why consider student-athletes as a separate student culture?” Gerdy (2006) explained that a distinct “athletic culture” (p. 22) has emerged across the each division of college athletics and across all sports. Students’ participation in collegiate athletics results in these student-athletes to encounter personal, academic, and athletic challenges that non-athletes will rarely, if ever, experience in their collegiate tenure. It is these sets of experiences, which separated athletes from the general student population, and caused researchers to consider student-athletes as a unique subpopulation of college students (Kissinger & Miller, 2009). Bell (2009) suggested that student-athletes become isolated from the general student population; thus, making it difficult for student-athletes to even develop relationships with non-athlete students.

Pascarella (2006) suggested that students' experience with diverse populations, and not simply racial or ethnically diverse populations, improve the intellectual and personal impacts of college. The author explained that it is important for students to have these diversity experiences both inside and outside of the classroom setting. Exposure to different people, ideas, beliefs, and world views force students to reflect their own perspectives, and promotes individual growth. Hu and Kuh (2003a) explained that encouraging students to interact with others from diverse backgrounds has positive effects on all those involved with the interaction. These positive effects were found to be directly related to students' participation in diverse experiences. Students' academic and social experiences help connect them to others with different perspectives and knowledge constructed through unique prior experiences. Hu and Kuh suggested that students' involvement with diverse cultures and experiences prepare students to live and work with others in a cooperative diverse society, improve students' intellectual development, increase gains in students' learning, and help students examine their own role in society. Thus, educators and researchers need to examine student-athletes' cultural relationships to increase the educational diversity and strengthen the overall education of the student-athlete population. This supports researchers' (Hu & Kuh, 2003a; Pascarella, 2006) desire to see increased research on the experiences and interactions of cultures defined by characteristics other than race or ethnicity.

Student-Athlete Culture at Higher Education Institutions

With evidence of the existence of a distinct student-athlete culture within higher education institutions, it was necessary delve further into this culture and attempt to understand student-athletes identity and how it was positioned in the collegiate environment. To gain a better understanding the distinctive athletic culture cultivating in our nation’s colleges and universities it was necessary to review the origins and development of this culture. The National Collegiate Athletic Association (NCAA) served as the governing body for intercollegiate athletic competition for a majority of collegiate athletic programs in the United States. However, the NCAA does not account for the beginning of intercollegiate athletic competitions in the United States.

The original intentions of the inclusion of sports within academic institutions were to create a source of entertainment for students and develop a sense of unity among a school's students and its surrounding community. Schools saw athletic endeavors as a way to improve students' health and promote a healthy lifestyle to others in the community. Additionally, schools believed that they may use the athletic competitions to further their academic mission through increased revenue, student enrollment, publicity, and alumni support. In contrast, businesses perceived these school sponsored athletic teams as a way to promote socialization, loyalty, fitness, team skills, and obedience; all skills valued in a workforce consisting of mainly physical labor. Businesses also looked to take advantage of the community support that the schools' athletic teams generated by using sports to distract their workforce from their business practices. Thus, as both the academic and business worlds saw benefits of incorporating athletics into educational institutions there was a push in the late 1800s to develop competitive school sponsored athletic programs (Gerdy, 2006).

As the competition between university and college sponsored athletic programs succumbed to the increased pressures of alumni and outside funding, sports became more dangerous to the student-athletes' health and marred with corruption. Students were becoming severely injured or killed during athletic competitions, particularly football. There were also students playing for multiple schools, sometimes for pay, and athletes who were not students at all participating in games. This lead to a public demand for action. President Theodore Roosevelt responded by pushing for the formation of a governing body for collegiate athletics, and in 1906 the Intercollegiate Athletic Association of the United States (IAAUS) was established to protect student-athletes from abusive practices. Four years later the IAAUS would change its name to the current governing body for collegiate athletics, the NCAA (NCAA, 2010).

Student-Athletes’ Identities

Student-athletes possessed a unique role within their college community, and this role presented them with many obstacles during their transition to college and overall college experience that the general student population rarely faced. The focus of the student-athletes’ athletic identity intensified due to the progression of the media’s coverage of intercollegiate athletics, resulting in their academic identity becoming ignored or disregarded. It is important that educators not allow this to affect their responsibility to provide student-athletes with a proper education. This means ensuring student-athletes possess the primary skills necessary to enter a highly competitive job market. Since mathematics is part of this fundamental knowledge it is essential that student-athletes acquire a strong mathematical background. To make certain student-athletes enroll in courses that provide high quality mathematical experiences, it is critical to understand why they would not enroll in such classes. Before research took place to address this concern, it was necessary to obtain an understanding of both the student-athlete and the factors that may influence their mathematical experiences. Student-athletes possessed a dual-role at their respective schools. They have an athletic identity that incorporates their experiences meeting the physical and mental demands associated with participating in college athletics, as well as an academic identity that involves their experiences fulfilling the role and responsibilities of a college student.

Student-Athletes' Academic Identity

Bell (2009) explored the influences of different groups of individuals with whom student-athletes associates their roles in various situation in the development of student-athletes' academic experiences by interviewing 41 football student-athletes, across five Division I higher education institutions, regarding their athletic and academic role-sets. The author found that coaches, teammates, athletic academic advisors, non-athlete peers, faculty, and parents influenced student-athletes' academic identity. Bell qualitative findings supported the work of Marx, Huffmon, and Doyle (2008). In their quantitative study *The Student-Athlete Model and the Socialization of Intercollegiate Athletics*, they reported student-athletes' parents, peers, and coaches significantly influence how student-athletes construct their academic and athletic identities. These sources of influence stemmed from the two aspects of student-athletes' identity: their athletic identity (coaches and teammates) and their academic identity (athletic academic advisors, non-athlete peers, faculty, and parents).

Student-athletes' coaches are one of the most influential individuals in shaping their academic identity (Bell, 2009). Coaches generally use this role to push student-athletes to maintain their academic eligibility, encourage student-athletes to complete their college degrees, and stress to the student-athletes the realities of their chances playing professionally. Furthermore, Ridpath (2002) found in his survey of 191 Mid-American Conference student-athletes that nearly 50% of these student-athletes reported that during their recruitment, coaches expressed that the student-athletes' academic wellbeing was their top priority. Humphrey, Yow, and Bowden (2000) explained that coaches identified their players' academic performance as one of the major sources of stress associated with their coaching position. Coaches specifically mention players' disinterest in graduating, maintaining academic eligibility, progressing academically, and committing academic fraud in regards to the stress related to the academic performance of their players. This stress could be a result of coaches facing possible athletic and financial sanctions on their programs by the NCAA. Whether motivated by the welfare of their athletes, fear of NCAA penalties, or some combination of the two, coaches continue to attempt to be a visible presence in encouraging their players to maintain a healthy academic identity.

While coaches promote a positive academic message to their players, how their players interpret their message can factor into how the message is received. Bell (2009) suggested when coaches refer to student-athletes' life after sports and student-athletes' future success that their players took the message to heart. Ridpath (2002) found that in general coaches would stress student-athletes' academics success and graduation over student-athletes' athletic successes. This stressed importance of student-athletes maintaining their academic eligibility led to student-athletes being more invested in their class attendance and study habits. This increased investment is evidenced in the comparison of college student-athletes' graduation rates in comparison to non-athletes (Delaney & Madigan, 2009). However, Gerdy (2006) suggested that if a coach believes that a course or a major will be too demanding for a student-athlete, the student-athlete is "advised" to pursue alternative courses or majors that may not be as challenging. Thus, if student-athletes' feel that a coach is advising them in a manner to satisfy NCAA academic regulations, student-athletes' have reacted negatively to such a message and resulted in a negative relationship with academic persistence and future career salaries of student-athletes (Bell, 2009). Ridpath (2002) found that more than half of his research participants playing football perceived that their coaches were more concerned with student-athletes maintaining eligibility than graduating college. This and other literature (Maloney & McCormick, 1993) suggested that coaches focus on student-athletes' academic success begins to diminish as the student-athletes start playing for their coaches, especially those in revenue sports. Student-athletes in Ridpath's (2002) study reported that some coaches would shift the focus from athletic success to academic success only during the off-season; when coaches did stress the importance of their academic endeavors during the season, often they would not provide student-athletes with adequate time to be academically successful.

This promotion of student-athletes' welfare has not come just from coaches alone. Athletic departments and educational institutions have become more invested in the success of student-athletes' academic endeavors through the development of academic support services designed specifically for student-athletes. Thamel (2006) explained in his article *Athletes Get New College Pitch: Check Out Our Tutoring Center* that many collegiate athletic programs now use their academic support services as a major tool in recruiting student-athletes. Former student-athletes also saw the importance of academic support services, and advise high school student-athletes to research the types of support schools offer through their academic support service programs (Hewitt, 2009). The framework for these academic support programs are based upon the work done by the University of Notre Dame in 1964. Notre Dame began its academic support service program for student-athletes in response to the increased demands on student-athletes. Universities spent more than a million dollars annually to provide student-athletes with tutors and other various academic support services. Through academic support services student-athletes were sometimes required to attend a set number of study hall hours, usually this depended on the student-athletes' GPA, or student-athletes may request the academic support services to assign a tutor to assist them with a particular course (Thamel, 2006).

While coaches remain a visible influence on student-athletes' academic identity, it is those staff within the academic support services were reported to be the greatest influence on the development of student-athletes' academic identity (Bell, 2009; Ridpath, 2002). Bell found that the academic support services assist the student-athletes by answering academic questions, providing academic motivation, scheduling student-athletes' courses to fit their athletic demands, enforcing time management, and aiding the student-athletes in finding tutors as needed. The rise of these academic support services aided student-athletes in finding academic advice and help outside of their more traditional sources of support such as their coaches, teammates, friends, and family (Wolcott & Gore-Mann, 2009). Segments of the student-athlete population expressed that they did not believe that they could have graduated without the support provided by their academic support services, especially with regards to male minority student-athletes (Ridpath, 2002). Thamel (2006) interviewed a football player from the Temple University that credited his time working with the university's academic support services for his improvement and newfound confidence in his mathematics courses. In addition to being credited for aiding with student-athletes in-class success, athletic departments' academic support services have also shown to contribute to student-athletes' success outside of the classroom (Tull, 2009). Research (Bell, 2009; Morris, 2009) suggested that even with this additional source of support in student-athletes' academic identity, student-athletes enrolled in Division I schools may still not have as much personal freedom as they may prefer when it comes to selecting a major or scheduling classes. There have been those (Gerdy, 2006; Johnson, 1985) calling for schools to maintain their academic mission by ensuring that student-athletes are not forced to choose between their educational future and their athletic obligations.

While student-athletes receive various types and levels of support from their coaches and academic support services, student-athletes lean on their peers for support as well. These peers include their teammates, fellow student-athletes, and even alumni student-athletes from other universities. This support is related to both student-athletes' academic and athletic development. Teammates and other student-athletes allow student-athletes to discuss their academic challenges and aspirations with those that share similar experiences. These common experiences help the student-athletes bond with one another and offer informed advice to their peers when needed. While former student-athletes possess similar experiences to current student-athletes, the support they offer to the current student-athletes is a little different. Former student-athletes can become mentors for the current population of student-athletes, providing insight into how student-athletes' decisions may impact their future and advice for navigating obstacles that arise in coping with the conflicts in their academic and athletic aspirations (Bell, 2009).

In order to develop a rich understanding of the culture of the student-athletes within a university, it was important to examine this culture from not only its members but from outsiders perspectives as well. These added perspectives help describe the group’s behavior, experiences, values, and forms of expression within the university. Perhaps outsiders may be better at illustrating the student-athletes’ culture than student-athletes themselves, since characteristics student-athletes’ deem as normal or routine may seem unfamiliar or strange to outsiders. Not only is it possible for outsiders to be effective in depicting this student-athlete culture, but it is possible that they can influence and shape the student-athlete culture through interactions with its members. Peers and authoritative figures serve as sources of influence on the development of student-athletes’ academic identities. Over the course of a student-athlete’s collegiate tenure, faculty members can play an increasingly important role.

Gerdy (2006) explained that there has been a long held tension between faculty, academic administrators, and board members with college athletics. Many of these academia members saw the college athletics' role as being in direct opposition to the values and purpose of educational institutions. While faculty perceived college athletics negative impacts on the institutions and communities that they work and live in, often faculty did little to attempt to get involved in aiding in the reform of college athletics. This was unfortunate, since faculty are the individuals who have the responsibility and power to shape their institutions academic values. Gerdy argued that faculty must realize that they do have this power to change the values of college athletics. The author went on to suggest to get faculty to take action, it is necessary to create an awareness of college athletics' impact on faculty at a personal level, and also remind faculty of their professional responsibility to their school's academic mission and to their students' educational future. Through an appropriate faculty initiative it may be possible to tap into college athletics' extraordinary influence to unify their communities and promote their school's academic mission. While this goal may be daunting in its scope and energy required to achieve, there are simpler and practical actions that faculty can take and still have a positive impact on college athletics' educational values. Faculty develop curricula and they are the ones that have the authority to ensure that the courses and majors follow their school's academic mission. Therefore, faculty's actions in the classroom can play an important role in ensuring student-athletes receive a quality education. Faculty are student-athletes' authoritative figures in the academic realm. Thus, faculty's interaction with student-athletes can help shape and influence student-athletes' educational beliefs and values.

Faculty can aid student-athletes in choosing their field of study and also help direct student-athletes on their career paths. This influence has resulted in some faculty becoming mentors for student-athletes or attempt to provide other avenues of support for student-athletes. As students transition to college they can begin to rely more on faculty for to learn from faculty's knowledge and advice in regards to their educational and career futures. Informal relationships between students and faculty have found to provide students with an increase in self-confidence, more enjoyable and stimulating college experience, whereas students who do not have a relationship with faculty have shown to be less motivated to perform academically. Faculty could have particularly significant positive effects on first-generation and underprivileged students (Komarraju, Musulkin, & Bhattacharya, 2010). It is this reason that Pike, Kuh, and Gonyea (2003) suggested that faculty attempt to allow students as many chances as possible to encourage connect with them and other students outside of the classroom. While first-year student-athletes have been found to interact with faculty more than the general student body, it still takes time to build relationships with faculty (Tull, 2009). Bell (2009) found that many student-athletes did not possess a positive relationship with faculty until their senior year of classes. There are cases were faculty develop negative relationships with student-athletes as well. Faculty can be more focused on student-athletes' athletic identity, choosing to discuss sports instead of academics, which can take away from opportunities to help develop student-athletes' academic identity.

Faculty's perceptions of student-athletes can also negatively impact the development of student-athletes' academic identity. As student-athletes transition from high school to college they not only have to cope with their new collegiate identity, they must learn to cope with the change of perception from being highly revered in high school to being viewed as academically inferior (Papanikolaou, et al., 2003). Simons, Bosworth, Fujita and Jensen surveyed 538 student-athletes at a university, in their 2007 quantitative study *The Athlete Stigma in Higher Education*, to discover how student-athletes believed faculty members and the general student population perceived student-athletes. This study reported that 33% of the athletes believed their professors viewed them in a negative manner, and only 15% of the athletes thought their professors perceived them positively. Furthermore, the surveyed reported that almost 70% of the student-athletes experienced direct negative stereotypical remarks from faculty members. Students' perceptions of faculty's attitudes towards them have been shown to be an indicator of students' academic self-concept, intrinsic motivation, and extrinsic motivation (Komarraju, et al., 2010). Aries, McCarthy, Salovey, and Banaji (2004) found in Division III and Ivy League schools that student-athletes perceived that as a group they faced greater academic challenges than non-athletes did. The authors suggest that student-athletes believed that their identity as a group presented them with difficulties in overcoming faculty's negative perception of student-athletes and earning good grades. Student-athletes are not the only individuals aware of these negative perceptions, Humphrey, Yow and Bowden (2000) explained that coaches also share concerns regarding faculty members' acceptance of student-athletes and athletic values within the university.

The negative perceptions of student-athletes may stem from the perceived stereotype that student-athletes do not possess the mental capacity of non-athletes. Early research (Carter & Shannon, 1940; Snoddy & Shannon, 1939) suggested that there were no statistically significant difference between the mental-ability of student-athletes and non-athletes. These studies indicated that participating in sports actually improved student-athletes bonds to their school, but it was not reported whether these connections were beneficial to student-athletes' academic achievement. However in more recent research, Beilock and McConnell (2004) reported that just being awareness of the perceived negative stereotypes effected student-athletes’ academic performance. No matter if individual student-athletes are highly skilled and highly motivated; their awareness of these negative stereotypes impacted their academic success. The authors suggested that the more motivated and skilled student-athletes were, the more likely they were to be affected by this stereotype threat. This followed the previous literature (Hu & Kuh, 2003b; Komarraju, et al. 2010) which suggested that students become more engaged in classes and put forth more effort in their class work when they perceive faculty as approachable and encouraging; thus, these negative faculty perceptions may hurt student-athletes' academic performance.

Student-athletes’ athletic identity can also cause conflict in a developing positive academic relationship with members of the general student body. While some student-athletes do build relationships with non-athlete students, often student-athletes’ athletic responsibilities create disconnect between them and non-athletes (Bell, 2009). Bowen and Levin (2003) reported that even at Ivy League and other elite schools that student-athletes are becoming more detached from the general student body. This may be a result of schools separating student-athletes from other students through the physical grouping of student-athletes together in student housing and dormitories, or the physical and cultural differences between athletes and non-athletes could be the cause of this isolation (Adler & Adler, 1985). Adler and Adler explained that student-athletes are not always perceived as actually a part of the student population, and that this can lead student-athletes to focus on their differences between themselves and non-athletes; creating a greater sense of separation between the two groups. As this separation grows, student-athletes’ peer subculture becomes more tight-knit and influential in student-athletes' values and behaviors.

It may not be just student-athletes' athletic responsibilities that causes student-athletes to become isolated from the general student population, a significant portion of the general student population perceived student-athletes in a negative light with regards to academics (Simons, et al., 2002). This negative view may be a result of the admittance of student-athletes with lower mean GPAs and entrance exam scores, and below predicted academic performance in college (Bowen & Levin, 2003). Hu and Kuh (2003b) suggested that students are more invested in relationships that they find friendly and supportive. This may explain why student-athletes tend to have deeper relationships with their teammates, since they can receive support from teammates both on and off the field.

Parents of student-athletes can also play an important supporting role in the developing student-athletes' academic identity. Pfister (2004) found that a majority of student-athletes relied upon their family during periods of stress. Bell (2009) suggested this is particularly true for those parents with experiences in higher education. These parents provided their student-athlete sons and daughters with advice from their own collegiate experiences that help student-athletes adjust to the academic and social challenges and demands that student-athletes encounter. While first-generation student-athletes might not be able to look to their parents for support on how to cope with these new collegiate experiences, these student-athletes' parents impart emotional support to their first-generation student-athletes. Bell explained that this lack of academic support from parents of first-generation student-athletes makes it critical these student-athletes to find other avenues of academic support and motivation.

Conflict Between Identities

In addition to adjusting to their academic role, student-athletes must adapt to their athletic role within their college and team. Many of the students participating in collegiate sports transition from an elite athlete among their high school competition to an average or below-average athlete among their collegiate competition. This can be very difficult for a student-athlete to cope with since such a large part of their identity stems from their athletic achievement. Papanikolaou, et al. (2003) suggested this feeling of inadequacy further intensifies due to the lack of personal relationship between the athlete and coach at the collegiate level, and can result in loneliness, self-doubt, and a general sense that no one cares about them. While some student-athletes report having negative or unsatisfactory relationships with their coaches, Humphrey, Yow, and Bowden (2000) suggested that coaches put themselves under great stress attempting to advance their student-athletes' physical, academic, and personal welfare. In regards to coaches' relationships with student-athletes it is not always the case that it is the thought that counts. Beilock and McConnell (2004) explained that when student-athletes have negative perceptions regarding their athletic endeavors, whether these perceptions stem from the increased level of competition at the college level or a perceived slight from their coaches, it can negatively impact their athletic performance. The student-athletes site the pressure to win as their greatest source of stress, thus as student-athletes' athletic performance suffers this only adds their stress (Humphrey, Yow, & Bowden, 2000).

While student-athletes receive support in the development of their academic identity from various sets of individuals, Marx, Huffmon, and Doyle (2008) found that student-athletes' parents tend to focus on scholastic success while peers and coaches focus on the student-athletes' athletic achievement. At the collegiate level, the influence of peers generally overshadows the effects of parental guidance. Unfortunately, these peers can negatively affect a student-athlete’s identity by coercing them to fall in line with perceived athlete stereotypes, such as lack of concern for academics, display of little intellect, and expectation of special treatment (Gerdy, 2006; Papanikolaou, et al. 2003; Simons, et al., 2007). Student-athletes' peer subculture can create mixed messages that make it difficult for student-athletes to assess their collegiate responsibilities and discern their roles at their institution (Gerdy, 2006; Tull, 2009). These perceptions do not originate solely from student-athletes' collegiate experiences. Student-athletes begin to develop their academic identity based upon their prior schooling experiences. To understand how these viewpoints developed it is critical to analyze student-athletes’ academic and athletic background.

Adler and Adler (1985) conducted a four-year qualitative study of a major basketball program. The authors found that as incoming student-athlete freshmen transitioned into their roles in a major athletic program that the initial differences among their academic aptitude, skills, and expectations diminished. Unfortunately, these reduced differences in academic performance were not the result of the academically weaker student-athletes becoming better students, but from the academically stronger student-athletes becoming less motivated and interested in their academic role. Adler and Adler suggest this reduction in student-athletes’ academic efforts may be the result of the increase in their sports athletic demands from high school to college. Student-athletes become local and national celebrities as they participate in big-time athletic programs, as the media publicizes student-athletes athletic accomplishments. Thus, this recognition can cause student-athletes to begin to believe that their athletic responsibilities are more important than their duties as a student within their school. This can result in increased tension between student-athletes' academic and athletic identities.

Whitner's and Myers's 1986 qualitative research article *Academics and an Athlete: A Case Study* outlined an educational profile of Mike Jones, a freshman student-athlete at the University of Toledo in 1984 who was identified as an academic high risk by the university's Athletes Educational Planning Program (AEPP). To develop an understanding of the student-athlete's educational background and establish academic goals, they held an academic consultation session. Mike divulged that throughout his high school education, his sister completed his class work and his teachers were lenient. These factors allowed Mike to pass high school. Unfortunately, Mike's high school academic experience is common; many student-athletes arrive to college underprepared for the scholastic rigors they face due to colleges' admission of academically unqualified and underprepared students, eligibility standards, and the time constraints of their athletic requirements (Maloney & McCormick, 1993; Papanikolaou, 2003). The NCAA attempted to address this issue by increasing the number of high school core courses required for incoming freshmen student-athletes from 14 to 16 in 2008 (NCAA Eligibility Center, 2007). Thurston Banks (2008) stressed in *Integrated Mathematics Courses and the NCAA Core Course System* the need for intensive mathematics courses to be included in the NCAA core course requirements, since many college programs demand that students complete at least one mathematics course beyond a developmental or remedial mathematic course. However, the number or type of courses the NCAA requires is meaningless unless the teachers evaluate athletes and non-athletes fairly.

Papanikolaou, et al. (2003) expressed concerns in their article, *The Freshman Experience: High Stress – Low Grades*, that student-athletes generally lack encouragement to foster their academic identity until they reach college; thus, creating many problems for student-athletes as they transition to their collegiate career. Since the student-athletes are unfamiliar with their role as a student, they arrive at college with little motivation or interest in their academics. This obligation to fulfill scholastic demands to maintain athletic eligibility frustrates many first year student-athletes. Student-athletes experience high levels of stress learning to manage their academic responsibilities within an intensive athletic schedule that consumes both their energy and time (up to 40 hours a week) (Simons, et al., 2007). Humphrey, Yow, and Bowden (2000) explained this time engaged in extensive travel and physically exhaustive activities related to their athletic commitment can be closer to 50 hours per week; more than twice that of the federally mandated maximum of 20 hours per week allowed for students participating in work-study grants. When one takes into account student-athletes time spent attending class and studying for their classes, the total number of hours student-athletes spend between the athletic and academic responsibilities each week is more than that of an individual working two full-time jobs. Unfortunately, many incoming freshman have underdeveloped time management and coping skills, which may lead to added difficulties with their coursework. These problems potentially generate further stress for the student-athletes, which can hinder their ability to complete rational or organized mental tasks making it even more challenging to maintain academic goals (Papanikolaou, et al., 2003). Student-athletes reported stress stemming from conflict between their dual-role responsibilities and the lack of time to properly address to everything going on in their lives. Student-athletes attributed significant stress caused by academic problems and athletic demands, specifically prepping for class, class attendance, and making up missed assignments. Student-athletes explained that the time, physical, and mental energy needed to sufficiently prepare for their class demands are often drained by the mandates of their team obligations. Humphrey, Yow, and Bowden (2000) explained that the student-athletes' stress caused by the conflict between their identities is detrimental to student-athletes' physical and mental health; hurting both their athletic and academic performance. This conflict between identities is even greater for student-athletes at Division I schools, particularly in regards to those participating in revenue producing sports (Tull, 2009). Tull explained that due to the lack of athletic scholarship opportunities at lower division schools, these student-athletes are often higher achieving students that arrive at college more prepared for the academic rigors of college. Added to the fact that athletic teams within Division I schools generally possessed more responsibilities than those teams affiliated with lower division schools.

The stress from continual conflict between student-athletes' athletic and academic identities can take a toll on student-athletes. Whitner's and Myers' (1986) research suggested a plan of support to benefit the educational development of a student-athlete. In a consultation meeting Mike, the student-athlete participating in the study, voiced his frustrations with his courses, and discussed the possibility of quitting school despite the fact that he, while struggling greatly, was academically surviving his classes. This was not a problem unique only to the student-athlete community, various student-counseling services, such as Getting Ready for College; list this frustration as one of the main reasons college students struggle (Gordhamer, n.d.). Mike's aggravation with school led to his avoidance of a series of consultation sessions, and when Mike finally returned he voiced his desire to drop out and his concerns for the consequences that would follow. Without the support from these meetings, it is not hard to imagine that Mike would have ended his collegiate career much earlier (Whitner & Myers, 1986). When a student-athlete chooses to withdraw from school, they are also withdrawing from their athletic commitment. Johnson (1985) claimed, in his article *Educating Misguided Student Athletes: An Application of Contract Theory*, that schools have a contractual obligation to their student-athletes to assist in their educational progress. Thus, it is in the interest of the entire university, not just the coaching staff and athletic department, to provide their student-athletes with support for all aspects of their collegiate experience. Lack of a coordinated college program and professional standards fail to support the individual needs of the student athlete.

The Importance of Mathematics in Higher Education

The above literature detailed characteristics of student-athletes' culture and how student-athletes develop their athletic and academic identities. Included in this discussion was how student-athletes' identities can be shaped by the influence of certain people and experiences in student-athletes' lives. Now comes to the question, "Why should the mathematics community care about student-athletes' experiences with mathematics culture?" Mathematics educators have the obligation to provide all students with equal opportunities and resources necessary to learn mathematics (NCTM, 2000). Not only is there a desire to provide students the opportunity to learn mathematics, but also have students develop sense for the underlying beauty or connections within mathematics. While these aspirations are noble, assisting in the development of students' understanding of mathematical content and the beauty of mathematics, they may appear rather shallow in students’ overall collegiate education. Therefore, there was a need to explore the importance of mathematics in higher education to provide justification for the need to investigate student-athletes’ experience with mathematics culture.

Required mathematics courses have shown to impact students' performance in subsequent classes as well. Green, et al. (2007) studied the effects of a College of Business's, at a large Midwestern university, decision to lower the mathematics prerequisites needed for admission into the business school. The College of Business found with the reduced mathematics requirements that students were enrolling in business school at a far greater rate than previous years. The authors examined how these new requirements impacted students' success in their later business courses. Green, et al. found that students' performances in business courses, particularly business statistics, were negatively impacted by the College of Business's loosened mathematics requirements. This conclusion is supported by the work of Pozo and Stull (2006). Pozo and Stull found that the requirement of a mathematics course increases students' effort in school and students' academic performance by two percentage points. Furthermore, the authors found that lower achieving students were the most affected by their participation in required mathematics courses. The Pozo and Stull noted this improvement could be an indication that students participating in remedial mathematics are receiving the assistance they need. While students' academic performance was shown to improve with their participation in remedial mathematics courses, their enrollment in remedial mathematics course was shown as contributing factor in reducing students' odds of second-year retention. Generally these remedial mathematics courses were designed to develop students' mathematical skills, particularly in algebra. Thus, Pozo's and Stull's findings are reflected in the work of Adelman (1999). Adelman suggested that students' secondary school mathematics background was critical in students' collegiate academic success. Students' who completed courses above Algebra II in high school were found to be more than twice as likely to complete their bachelor's degree as those who did not. Lesik (2007) argued that students participating in developmental mathematics courses designed to allow students to learn mathematics they were supposed to learn in high school improves student retention by establishing a connection between the students and the school. It is important to note that Lesik described developmental courses as offering higher level of mathematics than that offered in remedial courses.

Participation in mathematics has not only shown to improve students' academic performance, but majoring in a field that requires higher-level mathematics and passing a first-year mathematics course have also shown to increase the chance that students will return for a second year of college. Herzog (2005) investigated challenges and patterns in freshmen retention at public research universities by examining measures of high school preparation, first-year academic performance, multi-institution enrollment, and financial aid support on second-year enrollment. The author found that students entering into majors that required the completion of higher level mathematics courses were found to be more persistent in remaining in college than their counterparts whose coursework did not require a significant amount of mathematics. Herzog reported that not only pursuing a mathematically intense major reduced students' chances of transferring or dropping out of college, but students' academic success in their first-year mathematics course was one of the major factors in predicting students' retention at the college level. Additionally, students that avoid enrolling in mathematics courses during their first year of college were shown to be five times more likely to transfer or dropout of college.

Culture of Mathematics

For the purpose of this research, *mathematics culture* was defined as the mathematics community's individual and shared experiences, skills, values, forms of expressions, and social institutions that rooted in mathematics. These individual and collective ways of thinking, believing, and knowing are evident in the mathematics community's interaction with mathematical content, other members of the mathematics community, and with those engaged in learning mathematics. Thus, to gain an understanding of this mathematics culture it was necessary to gather information regarding how members of the mathematics community perceive mathematics in relation to non-members.

Mason and Watson (2008) explained that those engaged in learning mathematics perceive mathematics as a set of ideas and methods that can be applied to assist them in accomplishing some task; whether that task is a homework assignment or something applicable to a job outside of a school setting, such as determining the tensile strength of certain steel alloys. Often those involved in fields such as engineering, computer science, economics, and social sciences see mathematics as a means to an end to solve problems related to their field. This leads these learners to seek to relegate mathematics to simply a set of techniques that they can use as tools, and thus, their mathematical learning goals focus on becoming proficient in being able to use these tools as needed. The authors suggested that perception of mathematics as merely a toolbox ignores both the creative and constructive aspects of mathematics, and without this understanding it may become harder to apply mathematical concepts correctly over a broad range of situations. Not only can it become harder for those to use mathematics, viewing mathematics as a collection of tools can hinder one's motivation to become engaged in learning mathematics.

Instead of viewing mathematics as simply a means to solve problems, the mathematics community perceives mathematics as an avenue for creativity, offering opportunities for exploration through proofs, connecting mathematical concepts, and discovering applications for these mathematical ideas. Mason and Watson (2008) described the full appreciation of mathematical topics as including, "…exposure of underlying structure as well as the distillation and abstraction of techniques that solve classes of problems, together with component concepts" (p. 191). The mathematics community uses mathematics to derive examples to aid in the understanding of mathematical concepts. This is often where differences in the perception of mathematics arise between the members and non-members of the mathematics community. Members of the mathematics community view mathematics as the motivation for construction of examples to demonstrate, or contradict, conjectures. However, non-members of the mathematics community perceive mathematics as simply these concrete examples; and possess little understanding of the underlying mathematics that was used to create these examples.

Student Experiences with Mathematics Culture

Middleton and Spanias (1999) pointed to a deficiency in encouragement and classroom atmosphere for the deterioration in student attitudes and motivations towards mathematics. As students' perceptions of mathematics become more negative, they learn to dislike mathematics. Students begin to form the notion that mathematics is a subject were only the capable succeed and everyone else struggles or fails. Students that explain their failure in mathematics by citing their personal intellect and ability generally have an aversion to mathematic related courses and majors. On the other hand, students that direct their success in mathematics to their skills and effort tend to gravitate more toward mathematics related fields. Students believe their success in mathematics is completely dependent on their natural mathematical abilities. This type of attitude provides students with little motivation to apply themselves in the field of mathematics.

Achievement is a large influence on a student's motivation to succeed. A student's prior accomplishments in mathematics significantly affect their motivation to engage in higher levels of mathematics with the expectation to do well. However, students' understanding of the importance of mathematics has not affected the decline in students enrolling in mathematic related courses (Middleton & Spanias, 1999). Stage and Kloosterman explained in their 1995 quantitative research article, *Gender, Beliefs, and Achievement in Remedial College-Level Mathematics* that students view mathematics courses as obstructions that prevent them from pursuing certain careers, due to their inability to overcome their emotional or cognitive challenges in mathematics. On the other hand, some students' interests provide them with the motivation necessary to confront and conquer their deficiencies.

Students' interests play a critical role in determining their level of engagement within a course. Koller, et al. reported on the effects of interest in academic engagement and success in their 2001 research article, *Does Interest Matter? The Relationship between Academic Interest and Achievement in Mathematics*, explaining that students seek knowledge and endeavors that gives them a sense of adequacy and self-control. There are various avenues of interest a student can pursue in the attempt to attain these goals, and these paths are in direct competition with one another to hold students' interest; selecting one generally requires neglecting others. Providing students with a high quality mathematical education experience in school is critical to maintain students' mathematical interest. Schiefele and Csikszentmihalyi stressed, in their 1995 article *Motivation and Ability in Mathematics Experiences and Achievement*, that students' interest in mathematics reliably determines the student's experiences, grades, and level of achievement and understanding in mathematics. However, the converse of this statement generally holds true only early in schooling. As students progress through their academic careers, their' interests serve as the driving factor in their engagement with mathematics. Research suggested a positive correlation between an individual's interests and choice of academic major (Allen & Robbins, 2008).

CHAPTER III

METHODOLOGY

The purpose of the prior chapters was to inform the rationale and foundation for a study of the cultural relationship between student-athletes and mathematics at a Division I university. The research problem, research question, and significance of the study implied a need for the study. The basis for the study was developed through a review of literature focusing on student-athletes' identity, the culture of mathematics, and how students perceive and engage with mathematics. This indicated constructs that may serve as influencing factors in student-athletes' relationship with mathematics, including student-athletes' identity, mathematics education, authority figures, support systems, and career goals.

The purpose of the research was to investigate the culture of collegiate student-athletes' in relationship to the culture of mathematics at a Division I university. The study explored how this relationship and various perceptions are developed, by examining if factors such as student-athletes' identity, mathematics education, authority figures, support systems, and career goals influence their attitude, interest, and/or motivation to participate in or becoming involved with the culture of mathematics.

Research Framework

For the purpose of this study, a framework for social science research will be used (Crotty, 1998) to outline the content of the chapter. Following Crotty's (1998) framework for the social research process, four areas will be discussed: (1) epistemology; (2) theoretical perspective; (3) methodology; and (4) methods.

Epistemology

Epistemology is the study of the nature of knowledge, its validity, and its transfer (Hofer & Pintrich, 1997; Muis, 2004; Sierpinska & Lerman, 1996). A person's perception and understanding of what knowledge is, how individuals learn or acquire knowledge, how knowledge is transferred between entities, and how one can discern if others have learned inform the basis of that individual's personal epistemological beliefs (Hofer, 2000; Muis, 2004; Sierpinska & Lerman, 1996). Thus, as a researcher it is necessary to understand one’s philosophy regarding the nature of knowledge so that it may direct the investigation of knowledge within the world.

The constructivist philosophy served as a guide to discovering and studying knowledge that exists within the world. Constructivists advocate that knowledge is constructed through personal experiences and engagement within that world. The researcher’s personal epistemology followed the philosophy of radical constructivism as detailed by von Glasersfeld (1995) in that individuals construct their own subjective knowledge and interpretations of lived experiences; a notion that informed the researcher’s attempt to understand the knowledge constructed through the relationship between the subjective individual human mind and the objective world. Therefore, from this perspective even though the research populations of student-athletes, mathematics faculty, and athletic department staff share some common experiences, whether these experiences are athletic, academic, or occupational in nature, their individual perceptions and understanding of these experiences vary.

Theoretical Perspective

The researcher's radical constructivist epistemology informed the theoretical perspective adopted for this study. The theoretical perspective followed that of interpretivism which is an attempt "…to understand and explain human and social reality" (Crotty, 1998, p. 67). Using a theoretical perspective guided by interpretivism, researchers attempt to understand and explain realities through individual's experiences. Furthermore, to understand and explain university student-athletes' "...culturally derived and historically situated interpretations..." (Crotty, 1998, p. 67) of their relationship with mathematics culture within a university, by studying the individual experiences of student-athletes and mathematics faculty follows the interpretivism theoretical perspective.

Methodology

The methodology provides design principles for conducting a research study that helps ensure that "…purposes, questions, and methods of research are all interconnected and interrelated so that the study appears as a cohesive whole…" (Creswell, 2007, p. 42). Creswell outlined five approaches to qualitative research: (1) narrative research, (2) phenomenology, (3) grounded theory, (4) ethnography, and (5) case studies. The phenomenological research design as the most suitable approach in attempting to "...understand several individuals' common or shared experiences of a phenomenon" (Creswell, 2007, p. 60). This study followed the constructs of a phenomenological research design exploring student-athletes' and mathematic faculty members' "...common understandings and the meanings of common practices..." (Crotty, 1998, p. 79) as the groups interacted during student-athletes' mathematical education. Thus, the findings of this study served to construct a composite description which "portrays the essence of the experience" (Moustakas, 1994, p. 13) of the cultural relationship of collegiate student-athletes and mathematics.

The methods of research provide an outline for the different phases of the data collection. These phases focus on detailing the answers to the following questions: Where does the phenomenon occur? Who have experience the phenomenon? What information is collected? How is the information recorded? What issues occurred during the data collection? The phenomenological research design informed the approaches used to answer these questions (Creswell, 2007).

Research Population and Setting

Details regarding the population and setting of a study establishes a detailed description of the participants and environment at the focus of the research. The study was conducted at a public university in the western region of the United States with an enrollment of about 14,000 students from 50 states and 75 countries at the time of the study. The student body was composed of 61% females, 39% males, and 15% minorities. Varsity student-athletes comprise roughly 5% of the student population (Forbes, 2010).

Student-athletes at the university shared common athletic and academic experiences and participated in sports requiring similar physical and time demands that can hinder educational progress (Maloney & McCormick, 1993; Papanikolaou, et al., 2003; Pascarella, Bohr, Nora, & Terenzini, 1995; Pascarella, et al., 1999; Whitner & Myers, 1986). Academically, the student-athletes satisfied the NCAA's core course requirements during their secondary education career or had completed the necessary coursework at a prep school to participate in athletics at the collegiate level (NCAA, 2007). In addition, the students attending the institution had completed a minimum mathematic requirement to graduate and earn a degree. This required students to complete two courses that fall under quantitative reasoning. A description of these required courses is included in Appendix A.

To develop a basis for understanding mathematic faculty members' experiences with student-athletes, it was necessary to discover the mathematics department's role within the university and the various avenues that students interact with members of the department. The university's mathematics department is a doctoral granting program Undergraduate mathematics majors may choose from three different concentrations: (1) graduate school preparation, the purpose of which is to ready students for the rigors of graduate studies in mathematics through theoretical mathematics and proof-based courses, (2) applied mathematics, the goal of which is to prepare students for mathematics students may encounter in industry working alongside engineers or scientists, or (3) secondary education, the intention of which is to reinforce and supplement students with the mathematical knowledge necessary to teach middle school and secondary school mathematics. Students may also engage in interdisciplinary studies through the mathematics department to obtain a minor in mathematics.

Data Collection

The data collection of a study provides details regarding the sources and methods adopted to obtain information that allowed for the examination of a phenomenon. This study gathered data from five sources: (1) student-athlete interviews, (2) mathematics faculty interviews, (3) classroom observations (4) athletic department staff interviews, and (5) observations of the athletic department's Academic Support Services. A description of each data collection method will describe each procedure in detail.

Before any data collection began, Institutional Review Board (IRB) approval was obtained from both the researcher's university and the university which the research was conducted. Receiving approval involved the researcher meeting individually with the chair of the mathematics department and the deputy athletics director to discuss the purpose and logistics of the study. After the meetings, written permission of access to conduct research within the mathematics and athletics departments was provided by the mathematics chair and deputy athletic director. Documents submitted to both IRBs included the written permissions of access, proof of Collaborative Institutional Training Initiative completion for both the Basic/Refresher Course – Human Subjects Research course and the Social and Behavioral Responsible Conduct of Research course, sample letters of informed consent, sample interview questions, and sampling instrument used within the research. A copy of the researcher's university letter of IRB approval is found in the appendices (Appendix B).

Student-Athlete Data Collection

Researchers (Gerdy, 2006; Pascarella, et al., 1999) suggested that the academic issues surrounding student-athletes are prevalent across the NCAA landscape; educational institutions of varying location, size, and division that sponsor intercollegiate athletics all possess the athletic culture and the concerns that are involved with this culture. Therefore, the population for this study consisted of student-athletes affiliated with a western region of the United States Division I university's varsity sports programs.

The population was comprised of different classes of male and female student-athletes: freshman, sophomore, junior, and senior, with a variety of declared majors.

Sampling instrument. Creswell (2007) explained that as a phenomenological researcher it is essential to select participants who have experienced the studied phenomenon. Thus, to ensure the student-athletes participating possessed experience interacting with mathematics at the university, a developed sampling instrument to gather information regarding student-athletes' mathematical experiences was implemented. Since student-athletes can have varying majors with different mathematical content requirements, participants were categorized into three groups, low, moderate, and high levels of mathematical experience. To ensure that student-athletes from each of these groups were represented, a survey instrument was used to strengthen the external validity of the research (Merriam, 2009). The Mathematical Experience Questionnaire (MEQ) instrument prompted student-athletes to list the number and level of mathematics and mathematically related courses they have completed, enrolled in, or intended to enroll in during their collegiate careers (Appendix C). At the end of the questionnaire the student-athletes were asked to provide their contact information if they would be willing to be interviewed later.

The personal value system of the researcher directly affected the construction of the mathematical experience explanatory variable. It was the researcher’s perception that the completion of mathematics courses at or below the level of *College Algebra* or *Algebra and Trigonometry* constituted a low level of mathematical experiences, since these courses cover the least amount of mathematical concepts that satisfy the minimal quantitative reasoning requirements for graduation at the institution of the research.

Students with a moderate level of mathematical background, whose completion of mathematical courses above college algebra, but no greater than an introductory differential equations course, were categorized as a solid foundational knowledge of mathematics. While much of the population outside of the mathematical community may perceive an introductory differential equations course as an upper level mathematics course, those within the mathematical community consider an introductory differential equations course as an elementary mathematics course since its curricular content does not usually involve formal mathematical proofs. Therefore, for the purpose of this study, students with high mathematical experience were those that had engaged in formal mathematical proofs during their coursework.

The definitions of low, moderate, and high may not be consistent with the general mathematical requirements and perceptions of individuals with a non-mathematical emphasis nor that of the participants in this study. Due to the voluntary nature of the participants, definitions were not finalized until after reviewing the returned MEQs it may have been necessary to adjust definitions in response to actual participants' mathematical experience. Since it was possible that there may be student-athletes who are mathematics or mathematical related majors, such as engineering or statistics, which are only beginning their major coursework, a question on the MEQ asking for the student-athletes to provide their major was included. Student-athletes majoring in mathematics or a mathematical related field were possibly considered as high mathematical experience student-athletes, depending on their progress toward degree.

In an attempt to accumulate as many student-athletes as possible to select as interviewees, it was imperative that student-athletes felt as comfortable while completing the MEQ. To accomplish this, the questionnaire was sent to student athletes using email. Additionally, during the fall semester, the athletic department's head of academics assisted in forwarding the MEQ and consent forms to the student-athletes, with directions of how to send their responses directly via email. Unfortunately, only one student-athlete, a secondary education mathematics major, volunteered to participate through the described sampling technique. Further attempts to connect with possible student-athlete research participants stalled over the winter break and beginning of the spring semester as the athletic department transitioned to a new head of academics. After multiple discussions, it was decided that to best way to reach student-athletes was by adopting two approaches: (1) being present in the Academic Support Services study hall at peak hours and (2) appropriate incentives for student-athletes to participate in the research. Working with the head of academics and Academic Support Services staff it was possible to inform student-athletes of times available to meet within the Academic Support Services study hall and provide the student-athletes with a quick overview of the research. This method allowed the student-athletes to return their completed MEQs in person during study hall. The head of academics then provided the incentive for individual student-athletes to earning credit for two study hall hours and points toward an annual competition between the various teams to participate in service projects and academic workshops. These forms of compensation proved enough to encourage student-athletes to participate, while also satisfying NCAA regulations on student-athlete benefits.

The table below documents some brief descriptive information of student-athletes participants. The table groups student-athletes by the amount of mathematical experience.

Additionally, the information within the table includes whether they participate in a team or individual sport, number of years in college, and major.

Table 1

Descriptive Information for Student-Athlete Participants

Student-Athlete	Year and Major
Low Mathematical Experience	
Paul - Individual Sport	3rd year - Communications
Stewart - Individual Sport	1st year – Elementary Education
Shelley - Team Sport	3rd year- Women's Studies
Adam - Individual Sport	2nd year – Elementary Education
Jenna - Team Sport	1st year – Criminal Justice
Moderate Mathematical Experience	
Kathleen - Individual Sport	2nd year – International Studies and French
Katie - Individual Sport	2nd year – Wildlife Biology & Fisheries Management
Diana - Individual Sport	1st year – Chemical Engineering
High Mathematical Experience	
Kim - Individual Sport	4th year – Mathematics
Allyson - Individual Sport	3rd year – Secondary Education Mathematics

Two student-athletes interviewed, Adam and Stewart, were Elementary Education majors who were required to complete a sequence of three mathematics courses. The sequence involved preparing students for teaching mathematics concepts ranging from number systems and arithmetic operations to two- and three-dimensional shapes and measurements. In addition to the three courses, Elementary Education majors must fulfill two seminar education courses that examine mathematics concepts and materials related to elementary education curricula. It was determined that students enrolled in the Elementary Education major possessed low amounts of mathematical experience even though they are required to complete three mathematics courses, since the content of these courses focused primarily on elementary or basic mathematics.

Three other student-athletes designated as students with low amounts of mathematical experience were, Jenna (Criminal Justice), Shelley (Gender and Women's Studies), and Paul (Communication). Each of these majors required two quantitative reasoning courses which can include mathematics courses ranging from College Algebra to Calculus I. Therefore, it is possible for students majoring in Criminal Justice, Gender and Women's Studies, and Communication to possess greater than low amounts of mathematical experiences depending on their choice of mathematics course enrollment used to satisfy their quantitative reasoning requirements. However, Jenna, Shelley, nor Paul had enrolled at the time or planned to enroll in any mathematics course above a pre-Calculus level.

The three student-athletes interviewed, whom possessed moderate amounts of mathematical experience, were also pursuing different majors. Kathleen was double majoring in International Studies and French. Her International Studies curriculum recommended Kathleen to complete an introductory statistics course as part of degree, while her French curriculum only required Kathleen to complete two quantitative reasoning courses. From examining Kathleen's mathematical requirements it may be assumed that she would only have a low amount of mathematical experience, but she enrolled into a Calculus I course to satisfy mathematics requirements for her prior major of Architectural Engineering. Thus, Kathleen's coursework consisted of a mathematics course beyond that of pre-Calculus, which is why she was categorize as a student-athlete with a moderate amount of mathematical experience.

The other two student-athletes with moderate amounts of mathematical experience were both pursuing majors requiring mathematics courses above that of pre-Calculus. Katie's Wildlife and Fisheries Biology major required her to take at least a Business Calculus course and an intermediate statistics course. When interviewed, Katie had completed a Calculus I course and was enrolled in an intermediate statistics class. Therefore, Katie's major requirements and previous mathematical experience placed her into the moderate amount of mathematical experience category. Diana's Chemical Engineering major required her to take mathematics courses which include some proof-based content which could have categorized Diana as a student-athlete with a high amount of mathematical experiences. However, she was only a freshman and enrolled in a Calculus III course at the time of study, so she was categorize as a student-athlete with a moderate amount of mathematical experience.

There were two students in the participation pool that were deemed to possess a high amount of mathematical experience. Allyson, a Secondary Mathematics Education major was required to complete a series of proof-based mathematics courses. As a junior she had taken more than one proof-based mathematics course. Kim, a senior Mathematics major, had completed a number of required proof-based mathematics courses.

***Interviews*.** Due to the necessity to adopt two strategies for gathering student-athlete volunteers, two different protocols for meeting with student-athletes for interviews were employed. Unfortunately, only one student-athlete volunteered to participate. The interview occurred at the university's library in a closed-door group study room. At the request of another participant, interviewees were met immediately after submitting their MEQ. Interview occurred in a closed-door private tutoring room.

The method provided and appropriate protocol to purposefully sample the student-athletes who were willing to participate. Determined mathematical experience disclosed in the MEQs aided in the decision to interview the student athletes previously described.

At the beginning of each interview informed consent was introduced and discussed with each participant. Additionally, the possibilities of meeting for one to two short follow-up interviews were discussed with each participant allowing participants to provide additional comments or topics of discussion, expand on prior ideas, or clarify responses from previous interviews. The consent form outlined the measures taken to protect the participants’ confidentiality and privacy during the research and in all documents and publications that could result from the study. During this time, the participants’ were asked if they had a preference of pseudonym that would be adopted for the study. Once consent was attained each interview took between 15 minutes and an hour. To maintain the student-athletes' individual perspectives and understandings of their experiences, each interview was semi-structured and primarily consisted of open-ended questions. During the interviews, an initial analysis was conducted by recording field notes detailing participant's responses that were seen as important for either following or previous interviews (Merriam, 2009). All interviews were audio recorded and then later transcribed.

The primary interview established a personal connection with the research participants, and gave them an opportunity to discuss details of their experiences and perspectives without the researcher imposing assumptions or bias (Fontana & Frey, 1994). Since the aim was to gain an in-depth understanding of student-athletes’ behaviors and ways of thinking about their interactions specifically with the mathematics culture at their university, interview questions were constructed to serve as somewhat of a directive. Interview questions examined student-athletes' understanding of the student-athlete culture, as well as their prior educational experiences, perception of mathematics, educational goals, career goals, and influencing factors on their perception of mathematics (Appendix D). The interview data were used to develop a textural description of the student-athlete experience (Creswell, 2007).

The questions from each initial interview included some form of the sample questions listed in Appendix D, along with various follow-up questions. The questions were generated from existing literature concerning the culture of student-athletes and student-athlete academic success and factors influencing general student engagement and perception of mathematics. From the literature and expert consultation, five factors that either influence student-athletes' academic performance or general students' perception of mathematics: student-athletes' self-identity, previous educational experience with mathematics, authority figures' perceptions of the student and students' perception of authority figures, systems of support for aid and encouragement, and career motivations. Appendix E connects the sample interview questions with either its purpose or one of the five research constructs. At the end of each interview student-athlete participants were asked if there was anything more they would like to discuss such that we may need to schedule an additional interview time, but either each student-athlete found the initial interview to be enough in explaining their perspectives and thoughts or their schedule may have not allowed them time to meet a second time.

Mathematics Faculty Data Collection

Research (Grootenboer, 2013; Li & Zhao, 2013) suggested that students develop their mathematical knowledge through their mathematics classes. Furthermore, this exposure to mathematics is when students become introduced and absorbed into mathematical culture. Thus, mathematics teachers and their classroom practices significantly contribute to the formation of students’ mathematical identities. To develop a description of the cultural relationship between collegiate student-athletes and a mathematics department at this Division I institution, it was important to collect data from members of the school's mathematics department. This data provided insight into the mathematics faculties' experiences, values, and behaviors involving student-athletes. This provided the opportunity to capture the cultural relationship from the perspective of both cultures.

Interviews**.** In order to develop a level of trust with the faculty in the mathematics department an initial meeting was scheduled with the chair of the mathematics department to inform the department of the purpose of the research. The meeting provided the opportunity to obtain written permission from the chair to proceed with the research and to contact members of the mathematics faculty for participation in the study. While the chair granted permission to conduct research, he was explicit in requesting to refrain from using his name or title to influence or coerce any of the mathematics faculty into participating in the research. This meeting also allowed for consultation with the chair about the best methods for contacting faculty members.

The selection process for mathematics faculty and graduate teaching assistants to interview began by purposefully sampling three of the mathematics faculty and one graduate teaching assistant. Participants were chosen based on those who represented the mathematics culture to significant portions of students within the university through their teaching. In order to determine which of the members of the mathematics faculty met this criterion, there was a need to examine the mathematics requirements across a broad range of majors. From this examination, it was determined that three courses would be a part of the mathematical courses needed to satisfy most majors' requirements: (1) College Algebra, (2) Calculus I, and (3) one of the two pre-service elementary teacher mathematics courses. Using this information it was decided to contact mathematics faculty and graduate teaching assistants currently teaching or possessed recent experience teaching one of these three courses.

During the fall semester of 2012 mathematics faculty members and graduate teaching assistants whose teaching experiences aligned with the purposeful sampling were contacted via their university e-mail accounts. Responses were received from a graduate teaching assistant who was currently teaching both College Algebra and a pre-service elementary teacher mathematics course, a mathematics education professor who regularly taught a pre-service elementary course and possessed experience teaching calculus at the university, and a final response from the College Algebra coordinator who regularly taught College Algebra and also taught some calculus courses. These members of the mathematics department all served as ambassadors for the culture of mathematics to a diverse population of students within the university, and interviewing these mathematics ambassadors assisted in understanding how students interact with and experience the mathematics culture within the university. In addition to these three members of the mathematics department, the chair of the mathematics department also granted permission to interview him as part of the study. Interviewing the chair gave insights into his perception of the mathematics culture within his department and the direction he sees the culture heading. Below there is a brief biography of each of these individuals who are engaged in the promotion, teaching, and work in the field of mathematics within the university:

Table 2

Mathematics Faculty Participants' Biographical Information

Mathematics Faculty	Brief Biographical Information.
Dr. Sheehan	A former student-athlete who currently serves as the chair of the mathematics department. Has been associated with the university for more than 15 years. Possesses a doctorate in Mathematics and Medical Physics.
Dr. Sims	An associate professor of mathematics. Has been a member of the mathematics department for more than five years. Possesses a doctorate in Mathematics Education. Teaches mathematics courses that serve as part of a sequence for pre-service elementary teachers.
Daniel	A senior academic lecturer, is the course coordinator for College Algebra. Possesses a Masters in Mathematics. Teaches College Algebra and Calculus I.
Marie	A graduate student working on her doctorate in Mathematics Education. Teaches College Algebra and mathematics courses that serve as a part of a sequence for pre-service elementary teachers.

Interviews with the mathematics faculty and graduate teaching assistant were conducted in their respective offices on campus. Before proceeding with these interviews, participants were briefed on the study and informed consent. The participants were also made aware of the possibility of short follow-up interviews later in the year that would allow them to provide any additional comments or clarify responses from previous interviews. The consent form outlined for the participants the measures taken to protect their privacy in all documents and publications that could result from this study. The participants were also informed on the measures followed to ensure each participant’s confidentiality throughout the research. During this time, participants were asked if they had a preference of pseudonym that was adopted for the entirety of the research, and each participant responded that they did not have a preference. Then if the faculty member had no objections, the interviews proceeded. The interviews followed this protocol for all mathematics faculty participants except for the College Algebra coordinator. As the interview began, he explained that he needed more time to digest the questions and think about his responses, in particular, about his teaching philosophy. Thus, it was agreed to reconvene a few days after the first interview attempt to proceed with the interview. To maintain the mathematics faculty members' individual perspectives and understandings of their experiences, the interviews were semi-structured and mainly consisted of open-ended questions. The interviews took between 30 minutes to one hour to complete. During the interviews, initial analysis of the data began by recording field notes that detailed participant's responses that were deemed as important or that may be needed in follow-up or previous interviews. These interviews were audio recorded and then transcribed at a later time.

The primary interview established a personal connection with the research participants, and gave them an opportunity to discuss details of their experiences and perspectives without the researcher imposing assumptions or bias (Fontana & Frey, 1994). Since the purpose of the interviews was to develop an understanding of the mathematics faculty’s behaviors and ways of thinking about their interactions with students, interview questions were constructed to focus the mathematics faculty’s responses. Interview questions examined the mathematics faculty’s pedagogical practices as well as their perception and experiences with student-athletes (Appendix F). The interview data allowed for the development of a textural description of mathematics department members' experience with student-athletes and build an understanding of their individual and collective ways of thinking, believing, and knowing, in order to gain insight into the mathematics department's culture and its cultural relationship with student-athletes (Creswell, 2007).

***Classroom observations*.** The observation of the mathematics faculty’s classroom behaviors and instructional practices gave the opportunity to understand and capture the context within which the faculty interacts with both athletes and non-athletes. Understanding the context which mathematics faculty interacts with student-athletes was essential in developing an understanding of the cultural relationship between student-athletes and the mathematics culture within the university since it provided insight into student-athletes’ and mathematics faculty’s shared experiences, forms of expression, social institution, and behaviors.

Developing an understanding of the conditions, situations and context in which mathematics faculty and student-athletes interact made it so that it was not necessary to rely upon prior classroom experiences to interpret the interview data. This allowed for the observer to maintain an open mind to confirm or contradict the mathematics faculty members' interview responses by observing their actions, instead of relying on assumptions. Additionally, the fieldwork provided an opportunity to observe routine classroom behaviors or situations that the mathematics faculty may have been unaware of or taken for granted. Thus, this information could have been absent from the interview data since the mathematics faculty may find the regularity of these routines unimportant or to have little relevance to the study, and these may not be routine to the outside observer. The classroom observations also provide an opportunity to witness and learn things that the mathematics faculty or student-athletes were unwilling to discuss during interviews, such as providing student-athletes with additional assistance that non-athletes do not receive or criticizing student-athletes dedication to their academic work in relationship to student-athletes athletic responsibilities and how they portrayed the mathematics culture. After comparing the mathematics faculty interview data with the classroom observation data, it was determined that often the mathematics faculty members provided accurate portraits of their typical classroom practices and interactions with students.

The classroom observations provided an opportunity to collect data with the least potential of influencing the data. Since the observations were conducted without giving any direction to the students or teachers, allowing for themes and patterns to emerge naturally. During the observations, it was possible to shift the observational focus to gain a more in depth understanding of the teacher and student-athlete interactions. This flexibility allowed for the development of new ways to perceive and memo classroom practices and the teacher-student interactions observed. Possessing a solid mathematical background provided an understanding the content of the courses observed and the context of the teacher's practices and classroom interactions, which allowed for the focus of the observations to be on these classroom practices and interactions without needing to interpret and understand the course material and concepts. The interviews coupled with the observations enhanced the consistency and validity of the research by providing the data needed to develop deep, rich, thick descriptions of the student-athletes' relationships and interactions with members of the mathematics community at the university (Adler & Adler, 1994).

Since the observations of the class were completed in a natural setting and no directions were provided to the class, the potential for imposing researcher effects on the data were minimized. The diminished observer effects and lack of direction allowed themes to emerge naturally from the data. This provided the opportunity to develop theories and connections between these theories. As theories developed from the data, it was possible to make slight alterations in the focus of the observations to gain a greater understanding of the classroom practices and interactions within the class. This flexibility also provided the opportunity to observe the classes from a new perspective and reexamine previous observations in a different light. To minimize the effect and establish credibility in the findings of the study, the observations were conducted systematically and repeated over a variety of conditions, such as time of observation, course content, classroom population, and instructor of record. The interviews coupled with the observations provided rigor to the research design, and improved the consistency and validity of the study by adding breadth and depth to the data (Adler & Adler, 1994; Merriam, 2009).

Observation protocol. Following the interviews with the mathematics faculty, the faculty members were informed of the purpose and procedure for conducting observations of their classroom practices. During this time it was stressed that the observation would not involve the evaluation of the participants’ teachings.

Classroom observations of the mathematics faculty began by first observing a graduate teaching assistant, Marie, teach a College Algebra course before her class took their first exam of the fall semester in 2012. While Marie also taught a pre-service elementary education mathematics course, scheduling conflicts prevented the observation of this class. Similar scheduling conflicts prevented the observation of either the mathematics education professor's or the College Algebra coordinator's fall classes. Therefore, arrangements were made to observe both faculty members' during the spring semester of 2013. For the mathematics education professor, Dr. Sims, observations of her pre-service elementary education mathematics course started during the second week of the 2013 spring semester. This was the only mathematics course she was taught during this semester, so there was no other course of hers to observe that semester. For the College Algebra coordinator, Daniel, observations of one of his College Algebra course and his Calculus I course began during the second week of the 2013 spring semester. The observations involved attending at least two of the classes per week. This procedure was held consistently through the fall and spring semesters except for a few extenuating circumstances. In each of the courses observed there was at least one student-athlete enrolled according to the instructors, and at times up to 10 student-athletes enrolled in a course. While the instructors provided information regarding the number of student-athletes in each of the classes observed, it was difficult to identify the students who were student-athletes unless they were wearing a part of their teams' backpack or clothes. Thus, unless it was possible to specifically identify a student as a student-athlete, students were assumed to be non-athletes.

Before the classroom observations began, selective disclosure was used to inform the students within the classes of the purpose of the observations, explaining that the focus of the observations were on the instructional and student practices within the mathematics faculty's classes (Patton, 2002). Each initial classroom observation served to develop a feel of the classroom environment and the teacher-student interactions for each individual mathematics faculty member. In the observations, details such as the layout and size of the classroom were recorded, as well as the type of board and technologies used in the class so that it may be possible convey the physical and social environments (Patton, 2002). Attention was given to the manner which the students organized themselves in the classroom and the patterns in which the students communicated with each other and with the mathematics faculty. The mathematics faculty members' interview data served as part of the focus for much of the classroom observations, since the purpose of the observations was to confirm or contradict the interview data. In addition to this emphasis, the researcher continually referred to and adopted Tillman's (2002, p. 4) definition of culture as "a group's individual and collective ways of thinking, believing, and knowing, which includes their shared experiences, consciousness, skills, values, forms of expression, social institutions, and behaviors." Referring to this definition aided in focusing the observations to document instances that the mathematics faculty would demonstrate the mathematics culture's skills, values, form of expressions, and behaviors through the way they talked about mathematical norms, ways of promoting concepts, and gestures used to relay ideas. Additional observation notes were recorded for anything that appeared relevant to the study, which may not have been previously considered. These observations allowed for the development of a structural description of the situations and environment that members of the mathematics department interact with student-athletes (Creswell, 2007).

The development a detailed perspective of the cultural interactions between student-athletes and the mathematics community at the university took time, as the observations involved four mathematics courses during 2012-2013 academic year. The purpose of the observations was to confirm or deny overarching themes present within the interview data, as well as to provide insight into the patterns in the social interactions between student-athletes and the mathematics community. It was not possible to capture all of these social interactions or capture the individuals' perceived understandings of these social interactions from the classroom observations; thus, there were some informal interviews with the mathematics faculty throughout the observation process. For each course observation completed a one-semester cycle of observations to obtain data saturation (Merriam, 2009). The researcher's role as a peripheral member of the classrooms through the observations and informal interactions with the students in the classes aided in establishing the researcher as part of the class without participating in the class activities and therefore provided an insider's perspective of the class culture (Adler & Adler, 1994).

Athletic Department Staff Data Collection

Research (Bell, 2009; Gerdy, 2006; Papanikolaou, et al., 2003; Simons, et al., 2007) suggested that members of the athletic department were involved in student-athletes' academic and athletic identities. Thus, a study into the culture of student-athletes it was important to include the athletic department staff as population of focus to develop an understanding of the role the athletic department plays in student-athletes' education.

Additionally, studying the interactions afforded the opportunity to explore how it influences student-athletes' academic goals and achievement

***Interviews*.** Members of the university's athletic department staff were contacted via e-mail to ask about their willingness to participate in 20 minutes to one hour interviews. These participants included the deputy director of athletics, the head of academic support, the athletic counselor and head of tutoring, and the head women's soccer coach at the university. Selecting these four staff members from the athletics department provided variation in duties of athletic department staff within the department. The variation in responsibilities and interaction with student-athletes provided multiple perspectives on student-athletes' role within the university and how student-athletes fulfill their role, as well as providing additional insight into how academic faculty perceive and interact with student-athletes. The interviews with the members of the athletic department informed the researcher's decision to interview two members of the university's athletic planning committee. This committee served as a way for the academic faculty and athletic department to communicate with each other about upcoming issues or review of previous concerns. Interviewing these members of the athletic planning committee provided insight into how the athletic department functions within the university. The table below provides a brief biography of each of the individuals who were engaged in the university's athletics department operations:

Table 3

Athletics Department Staff and Academic Faculty Involved in the University's Athletics Department Operations Biographical Information

Staff and Faculty	Brief Biographical Information.
Luke	Deputy Director of Athletics. Oversaw every aspect of the athletics department, such as academics, compliance, sports medicine, and strength and conditioning areas. His responsibilities also involved budgeting, marketing, facility projects, and liaison to various campus offices.
Abe	Associate Athletics Director and Head of Academic Services. Oversaw the coordination of any and all academic support for the student-athletes at the university, and also served as an academic counselor for student-athletes.
Julia	Assistant Athletic Director. Oversaw tutoring services within the Academic Support Services, and served as an academic counselor for student-athletes.
Flint	Head Women's Soccer Coach. Has been associated with the university for less than five years.
Angie	Academic faculty representative and chair for university's Athletic Planning Committee.
Dr. Cofer	Academic faculty representative for university's Athletic Planning Committee.

Before proceeding with the interviews, participants were briefed on the purpose of the study and the informed consent. The consent form outlined for the participants the steps taken to protect their confidentiality and privacy in the research and all documents and publications that may result from this study. During this time, the participants' were asked if they had a preference of pseudonym that would be adopted for the study. Once consent was attained each interview took between 20 minutes to one hour. To maintain the athletic department staffs' individual perspectives and understandings of their experiences, the interviews were semi-structured and mainly consisted of open-ended questions. During the interviews, an initial analysis of the data by recording field notes that detailed participant's responses that were seen as important for either following or previous interviews (Merriam, 2009). These interviews were audio recorded and then transcribed later.

The primary interview established a personal connection with the research participants, and gave them an opportunity to discuss details of their experiences and perspectives without the researcher imposing assumptions or bias (Fontana & Frey, 1994). Since the purpose of the interviews develop a sense of the athletic department staff's understanding of the student-athlete culture within the university and how this student-athlete culture interacts with various academic departments at the university, interview questions were constructed to focus the interview discussions (Appendix G). The interview was used to develop a textural description of the athletic department staffs' experience with student-athletes (Creswell, 2007).

Academic Support Services observations. In order to develop a structural description of the situations and environments that members of the athletic department interact with student-athletes, it was necessary to conduct a series of observations within the university's student-athlete Academic Support Services (Creswell, 2007). The inclusion of these observations provided the opportunity to observe and experience improvised interactions with student-athletes and members of the athletic department staff. Since these were not coordinated interactions, it was difficult to predict all the events that transpired. It was important to remain vigilant during these observations in order to take advantage of opportunities to gain a deeper understanding of the nature of student-athletes interactions. This involved recording what student-athletes did and said to their peers (Patton, 2002). To address ethical concerns of entering the Academic Support Services and interacting with student-athletes or athletics department staff through misrepresentation (Adler & Adler, 1994), permission was first gained from the head of academic support to carry out the observations, and then it was important to inform the student-athletes encountered of the purpose of the observations. These observations also served as a means of triangulating and verifying athletic department staffs' and student-athletes' interview responses. The observations of the Academic Support Services provided the opportunity to observe student-athletes interacting with other student-athletes and with members of the athletic department staff, and thus providing insight into student-athletes' and athletic department staffs' shared experiences, forms of expression, social institutions, and behaviors. The observations of the student-athletes interacting with other student-athletes, academic counselors, and tutors within the office of Academic Support Services were conducted at various times of the day throughout the 2012-2013 academic year until a repeated pattern of behaviors and interactions from the student-athletes emerged from the data which indicated a saturation of the data.

In addition to observations of the Academic Support Services, data were gathered regarding the history of the Academic Support Services within the athletics department and its influence on student-athletes' culture and education. Understanding the history of the athletics department and Academic Support Services provided a greater sense of context regarding student-athletes' social environment within the university (Patton, 2002). The following questions were asked to develop knowledge of the program's history: (1) How the program was created and funded? (2) Who does the program serve? (3) Has this population changed over time? (4) What services are provided through the program? (5) How have the program’s services and goals evolved or changed over time? (6) Has the program experienced any type of crises? and (7) What is the history of the program in relation to the university (Patton, 2002)?

Data Analysis

The data analysis of a study details the groundwork for organizing the data collected for analysis, the analysis process for condensing and focusing the data, and the approach for representing the data through the findings of the research (Creswell, 2007).

Procedure for Analysis

Through the interview and observation data, a composite description of student-athletes’ relationship with mathematics was constructed. The description is presented in Chapter 4 and provides the essence of the cultural relationship between student-athletes and mathematics at the university. To convey the discovered essence of the cultural relationship, quotes from the raw data were used to illustrate student-athletes’, mathematics faculty’s, and athletics department staff’s experienced with the phenomenon. The following details provide the procedure for analyzing the data collected to develop the description of this cultural relationship.

***Phase I*.** Due to the deficiency in research involving the culture of student-athletes and mathematics, there is no current evidence that these constructs are indeed factors that influence student-athletes' perception and engagement of mathematics. Therefore, the research was explorative in nature. The exploratory quality led to the review of the audio-recording of an interview immediately following the completion of each interview. During this time field notes were compared to the audio data to either expand upon the researcher notes and/or make corrections. The initial analysis generated topics that could be asked or observed in the following round of interviews, and maximized the recognition of preliminary themes present within the data (Merriam, 2009).

The explorative nature of the research also led to the reading printed copies of the interview transcripts with an open mind, removing researcher assumptions and personal viewpoints, ensuring that themes that developed from the data and were not forced upon the data from personal experiences and beliefs (Crotty, 1998). Data analysis began through an open coding process with the intention to develop axial codes, and eventually establishing selective codes (Creswell, 2007). The process involved reading through interview transcripts and observation notes, making notes of codes for various segments of the transcripts so that segments could be organized into a coding glossary book; creating and defining codes as needed. However after an initial analysis of the interview and observation data, the coding glossary book and notes were reviewed to check for understanding and validity of the preliminary codes, in an attempt to condense these open codes to axial codes. During this review, the open coding strategy of analysis was cumbersome and impractical due to the overwhelming number of codes developed. Furthermore, the expanding set of codes was too unfocused, and was not addressing the research constructs. Referring back to the research question and purpose of this study, it became apparent that this open coding exploration was not the appropriate method of data analysis for this study.

Instead of following an open coding analysis, a constant comparative approach was adopted to analyze interview data. This allowed for the differentiation of themes to emerge from the data and allowed for the identification of properties of these themes. Comparing a participant's responses within an interview and across other participants' interviews provided multiple perspectives to address different aspects of the cultural relationship student-athletes have with mathematics. This comparison gave an opportunity to find differences and similarities in participants' response regarding specifics of their experiences. The differences served much like non-examples, aiding in the development of an understanding of emergent themes.

The initial intention was to analyze student-athletes' interview data across their different levels of mathematical experiences to explore if student-athletes' mathematical experience may affect how student-athletes' regarded the research constructs. However, after a couple iterations of the comparison process this decision only seemed appropriate in the analysis of student-athletes' reasoning for their choice of major, perception of mathematics, and influence of their mathematics education experiences. The reason for this stemmed from these were the areas that student-athletes discussed common ideas across each level of mathematical experience. However, for in the analysis of the student-athletes' role within the university and the influence of student-athletes' identity, support systems, authority figures, and career goals what aspects of these constructs student-athletes focused to share and how student-athletes talked about these constructs did not necessarily align with the categories of mathematical experience. Hence, it was decided to analyze the student-athletes' responses for these constructs as a whole to capture the fullest description of if and how these constructs influenced student-athletes' perception and engagement of mathematics.

While the analysis of student-athlete interview data provided the information necessary to construct a description of the student-athlete culture, there was still a need to develop an understanding of the local mathematics culture. Thus, the mathematics faculty interview data were analyzed as a whole to portray the mathematics department's role within the university, how they expose students to the mathematics culture in their classrooms, and how the mathematics faculty perceive and interact with student-athletes. This analysis followed the thematic development through constant comparison strategy adopted for the analysis of the student-athlete interview data.

***Phase II*.** The initial phase of the data analysis was designed to develop descriptions of both the student-athlete culture and the mathematics culture at the university. The second phase of the data analysis focused on validating the findings from the first phase of analysis following an analytic induction process. Analytic induction is a method of data analysis in which the researcher begins with a deductively constructed hypothesis regarding a phenomenon, and then proceeds to examine the phenomenon to support or reject the hypothesis (Patton, 2002). The first phase of the analysis process served as the foundation which themes were developed. These themes served as hypotheses for the cultural relationship between student-athletes and mathematics at the university. The classroom observation data and athletic department staff interview data provided the necessary information to validate or elaborate on these previously developed themes. Analytic induction also provided an outside perceptive to statements made by the student-athletes and mathematics faculty. This employment of an analytic induction analysis allowed for the assessment of findings throughout the data analysis process (Merriam, 2009).

Trustworthiness

Moustakas (1994) explained that phenomenological research is valid when the essence of an experience studied can be understood through one's accounts and descriptions of the experience. Often the validity and reliability of qualitative research lies within the trustworthiness of the research. This trustworthy quality allows for the audience to trust a researcher's methods and findings, and also gives the audience the opportunity to deem the results worthy of their consideration (Merriam, 2009). Patton (2002) suggested that the importance of having trustworthy research is not to ensure the audience concurs with one's findings, but that it allows the audience to understand one's interpretation and conclusion of the research.

While some aspects of the trustworthiness of the research have been touched upon earlier in the data collection methods, for the reader's convenience these aspects will be expanded on and explicitly discussed in this subsection. The following paragraphs will explain the manner in which credibility, consistency, and transferability were established. In qualitative research these terms are often used in place of the quantitative terms of interval validity, reliability, and external validity (Merriam, 2009). In designing the study, experts were consulted with varying backgrounds, a collegiate assistant athletic director, a former collegiate athletic director, two educational mathematics professors, and a qualitative research professor. These discussions directly lead to development of the initial method for distributing MEQs to the student-athletes and the purposeful goal of variation in the sampling of participants from the returned MEQs, the maximum variation in the study (Merriam, 2009).

Various sources of data (triangulation) produced research constructs (Merriam, 2009). The review of literature and discussions with experts identified five constructs that could influence student-athletes' perception and engagement of mathematics. These constructs included student-athletes' identity, authority figures, career goals, educational experiences and support systems.

A triangulation process was not only used in the development of the research constructs, but also used to compare the perspectives of the different research participants: the student-athletes, mathematics faculty, and athletic department staff. Observational data also provided structural data (Creswell, 2007) which allowed a comparison with the interview data. Outside the data gathered from individual interviews and observations, documents such as the university handbook, athletic schedules, and NCAA guidelines were used to verify participants’ responses involving their athletic requirements, course description or requirements, and eligibility standards (Patton, 2002).

To ensure that an authentic and accurate representation of the participants’ interview responses was developed, upon the completion of the thematic development of data each participant was provided the individual sections of text to which included the participants’ responses. This form of member checking (Merriam, 2009) allowed the participants to review their comments and make certain that the results from the interviews reflect their true experiences and intentions. Four participants responded, Allyson, Luke, Dr. Sheehan, and Marie. Allyson, Luke, and Dr. Sheehan and explained that they would read through the results and at the time had no reservations. No further emails regarding the findings were received. Marie explained that she had no concerns with the findings, but commented that she was somewhat frustrated that she presented mathematics in a procedural manner in her College Algebra class.

During the data collection process it was important to remain engaged in gathering interview and observation data until the data reached saturation. Corbin and Strauss (2008) described saturation of data as the point in which no new data or themes emerged in the collection of data. Saturation occurred when the researcher spent an adequate amount of time engaged with the research participants, and when repetitions began to become present in the observation data and research participants no longer provided new details regarding their experiences with the studied phenomenon (Merriam, 2009). Data saturation did not mean that the data collection process came to an end once data supported previously established cases or themes. The data collection continued, as the researcher searched for counter or discrepant cases as well, in attempts to find instances that may contradict initial findings. Seeking these alternative explanations increased the confidence in originally established themes or explanations (Merriam, 2009). Corbin and Strauss (2008) warned that the complete saturation of data is difficult, if not impossible, to achieve. With this warning, Corbin and Strauss advised that if the researcher determines that the themes and explanations from the data provided depth and breadth to the understanding of a phenomenon, then the researcher may conclude that one has reached an adequate engagement in the collection of data. While it was not possible to interview as many student-athletes with moderate or high amounts of mathematical experiences as originally intended, the interviews with the student-athletes yielded data which gave both depth and breadth to understanding the cultural relationship between student-athletes and mathematics at a Division I university.

Throughout the study, research notes were maintained to document the progress of the research. These notes detailed the progression of the research as contacts were established within the mathematics and athletics departments, sought out research participants, and collected interview and observational data. Details from these research notes are presented within the methodology, such as the description of the steps taken to obtain student-athlete participants, as a form of an audit trail (Merriam, 2009) to provide an account of the research process, thus, giving the audience insight into the researcher's decision-making process and information to reproduce the research. The audit trail also strengthens the consistency, or in quantitative terms, the reliability of the research. In addition to outlining a record of the research process, the research log served as a confessional, giving insight into the successes and struggles of interviewing participants in their natural setting. This reflective quality provides a sense of reality and truthfulness to the study (Adler & Adler, 1994).

The presentation of the research's results and findings also lends to the trustworthiness of the study. The results are presented using concrete examples and quotes from the observation and interview data, and thus allowing the reader to analyze the interpretations and findings. While it is not necessary that the reader agree with the findings, the presentation of research should allow the reader to develop an understanding of how conclusions were determined (Patton, 2002). The use of rich, thick descriptions in the presentation of the results also lends to the transferability, or external validity, of the research (Merriam, 2009).

Role of Researcher

As a researcher, I desire to be aware of and acknowledge any assumptions, bias, and theoretical or ontological perspectives that may influence the study (Merriam, 2009). Undue and unspoken bias could potentially undermine the objectivity and validity of the results of the study; thus, hampering the ability to generalize conclusions from the research (Crotty, 1998; Gall, Gall & Borg, 2003). Therefore, detailing the role of the researcher and potential subjectivities and biases also maximizes study trustworthiness. This information provides the researcher’s background information to aid the reader to understand the lens in which the data were interpreted.

As I progressed through my mathematical education, I became a member of the mathematical community. As a member of this community, I have a stake of ensuring the community not only remains healthy, but also flourishes. One way that I can do this is by seeing that the mathematical community maintains a sustainable number of members. Understanding student-athletes' cultural relationship with mathematics may aid in the mathematical community's engagement of this particular student subpopulation, and thus giving the mathematical community a larger and more diverse recruitment base.

Many of my own secondary and university academic experiences are intertwined by my athletic experiences in school. During my high school career, I participated in the school's varsity soccer and tennis teams. My participation in soccer continued to a university's club soccer team. Thus, during this research I must be vigilant in ensuring that I do not allow prior experiences to become imposed on the student-athlete participants within the study.

As the researcher, I must also discuss my perspective of the role athletics plays within an educational institution and my connection with university athletic departments. It is my belief that athletics provide an event and common goal for faculty, students, alumni, and the community of an educational institution to rally around together, and thus serving a vital function in establishing camaraderie and strengthening the sense of community of the school. During my undergraduate studies and following master's studies, I worked within a division one athletics department at a public university as a private mathematics and statistics tutor to some of the student-athletes at the school. This gave me firsthand experience with a sample of student-athletes and their mathematical abilities and perceptions. In addition to these one-on-one interactions with student-athletes, my duties as a teaching assistant at multiple universities have included teaching courses in which student-athletes were enrolled.

My experiences with student-athletes go beyond that of the instructor-student dynamic. In the spring of 2009, two colleagues and I conducted a quantitative study focusing on student-athletes at a Division I university in the western region of the United States. This quantitative research involved a cross-sectional survey of 369 student-athletes at a Division I university in the Rocky Mountain region to determine if sport, gender, major and depth of mathematical experience influences student-athletes' attitudes towards mathematics. The analysis of the survey examined the connection between student-athletes' support system, authority figures, career goals, and educational experiences as they relate to student-athletes' attitudes toward and value of mathematics

(Roberson, Capels, Yacoub, 2009). Through the use of ANOVA’s, there proved to be no statistically significant relationship between student-athletes’ sport and their mathematical perceptions. Similarly, we found there to be no statistically significant relationship between survey responses and the student’s sport and mathematical experience.

Due to the lack of statistically significant findings, it was determined that a qualitative follow-up to our research might produce further insight into the nature of the relationship between student-athletes and mathematics. It was thought that conducting interviews with the student-athletes, it may be possible to construct a rich, thick description of student-athletes’ perceptions towards mathematics.

To gain a better understanding of student-athletes' relationship with mathematics, I conducted a phenomenological study in the fall of 2010 to explore how collegiate student-athletes constructed and perceived their relationship with the field of mathematics (Roberson, 2009). The goal of the pilot study was to develop an understanding if and how student-athletes’ identity, authority figures, career goals, educational experiences, and support systems influence their attitude, interest, and motivation in pursuing mathematical or mathematically related fields of study.

The findings of this pilot study provided evidence of multiple influencing factors in student-athletes' perception and engagement of mathematics. The constructs developed from the literature and expert consultation appeared to coincide with the findings from the participants' interview data. There was one exception though, neither student-athlete interviewed referred to their career goals as an influencing factor in their perception or engagement of mathematics. Instead the data gave evidence that their career goals may be more of a culmination of the other constructs in regards to their engagement of mathematics. The research data also suggested that the student-athletes' experiences with their mathematics teachers was one of the common influencing factors in their perception and engagement of mathematics.

Another interesting result from the data involved how both student-athletes identified themselves as role models. This idea of performing in a manner that can be followed, seem to influence the student-athletes' behavior inside and outside of the classroom. Whether or not both student-athletes adhere to their goals as role models could be determined from the study. Still, the thought that their actions could affect the manner in which others conduct themselves can be a large factor in controlling their own actions. The student-athletes explained that the athletic department has a desire for their student-athletes to be positive role models so when an individual recognized a student-athlete, that person would perceive them as being special. This special quality that student-athletes possess is their identity. Their identity is the face of the university. If a university wants to promote their student-athletes as one of its faces or ambassadors, the university should also want to promote a diverse face possessing varying educational backgrounds and goals. With this goal in mind, it may be possible to persuade universities to promote research in determining how collegiate educators and athletics departments can work together to alter student-athletes perceptions of mathematics and encourage their engagement in mathematics.

These studies informed the need for research to develop a descriptive understanding of student-athletes relationship with mathematics. Interviews with student-athletes provided just a small snapshot of student-athletes cultural practices. The interviews gave insight into their perspectives on mathematics, but without gathering data regarding their experiences in the mathematics department and their experiences with mathematics faculty there was not a complete picture of student-athletes relationship with mathematics culture. Thus, it was determined there was need for complementary perspectives from mathematics faculty and athletic department staff members on the cultural of student-athletes and student-athletes' experiences with mathematics.

CHAPTER IV

RESULTS

The purpose of this chapter is to summarize the results of the phenomenological study described in the previous chapter. Building on the descriptive accounts of the participants in the methodology chapter, the results include a contextual and structural description of the cultural relationship between student-athletes and mathematics to address the research question. Results relating to the five constructs within the research question were developed through a thematic development process. The following results provide a composite description to answer the research question:

Q1 How do perceptions and the relationship between the culture of collegiate student-athletes and the culture of mathematics develop at a Division I university?

Q2 Does student-athletes' identity, authority figures, career goals, support systems, and mathematics education influence their attitude, interest, and/or motivation to participate in or becoming involved with the culture of mathematics?

The following sections in this chapter provide descriptions of both the student-athlete culture and the local mathematics culture. These results outline student-athletes' identity, and focuses on how student-athletes engage with the mathematics culture. This focus examines how student-athletes' perception of mathematics and how their mathematics education experience, support systems, authority figures, and career goals influenced how they engaged with the local mathematics culture within the university.

To offer a more complete description of the phenomenon studied, the results provide analysis for how members of the mathematics faculty perceive the mathematics department's role within the university and perception of mathematics. Also, to provide additional perspective for the interactions between the student-athletes and the local mathematics community, there is an examination of the mathematics faculty's perception and experiences with the student-athletes. Thus, as a whole, the results provide a description of both the student-athlete culture and the mathematics culture, and portray how these two cultures perceived and engaged with each other.

Student-Athlete Culture

In order to develop an understanding of the student-athlete culture and its relationship with the local mathematics culture it was necessary to consider how the student-athletes perceive their role and identity within the university. Examining the student-athletes' individual and collective perceptions of their role aided in constructing a contextual description of the student-athletes' lived experiences.

Many of the student-athletes explained that their athletic responsibilities were a significant part of the collegiate experiences. Allyson described her season:

> So we start in October, is our very first meet. Then we'll usually have a meet almost every weekend until about the beginning or middle of November. Then we don't compete, but we're still in season, and our season ends the very end of February. So when we get back in school…so like obviously, like January, we're gone almost every weekend. Then conference is our biggest meet at the very end of February, and that's in like three weeks right now.

She went on to give a brief rundown of her typical week, "When we're in season…like for the month of January we missed every single weekend, so every Friday of classes. That's just hard because you're either on the road or have a meet. My days off are Sundays, but usually they're just full of homework." Allyson conveyed that her life was in “crazy mode” during the peaks of her season. Adam echoed this sentiment, explaining that, “…being an athlete is tough. It can be real tough with school because you have a pretty mandated schedule. You go to class from 8 o’clock to 2 some days, and then go from practice 3 to 6, and then study hall from 6:30, 7:30 to 9.” Shelley reflected on her time as a student-athlete as being, “…both mentally and physically straining.” She went into further detail “You go to school, you come back. Then you have to go to practice or a game and you have to perform. You have to perform in the classroom.” These student-athletes each described their identity as a student-athlete as going back and forth between their athletic and academic responsibilities. Adam explained, “It can be tough, but I like it.” This perception that the dual commitment between academics and athletics as being something of a challenge which student-athletes took pleasure in, as many of the student-athletes interviewed expressed their enjoyment of their collegiate experience. Comments such as Allyson’s, “I definitely pour my heart and soul into…I wouldn’t do it for 20 hours a week if I didn’t love it.”, Kathleen’s, “Really busy with athletics, but really rewarding and the different accomplishments that can come with that. It’s kind of stressful at times.”, and Shelley’s, “Yeah, I love it. I don’t want to leave.” illustrate how they perceived their experiences as student-athletes at the university.

Kim recounted her experience as a student-athlete at her last school:

> At my last college we would practice every day for like five hours, no joke… and that wasn’t even during the season. During the season we would travel far away because there wasn’t any good competition close. By the time I got done working and going to practice, it was hard to study.

However, since transferring to the university she explained how she was able to have more designated time to study, “Here I don’t have to because I get a little bit more money, so I don’t have to work, so I just go to practice and I get to come home and get to study. I'm done within an hour and a half, that's the longest practice and that's pushing it." Kim described how the shift in being able to focus on her academic responsibilities impacted her perception of her collegiate experience, "I get time to study so I'm more relaxed, and I just feel good. I go to class and I know what's going on versus going there and be like, well, I haven't been here forever and I'm so lost that I can't even focus." This depiction of the stress Kim felt from the conflict between her athletic, academic, and work commitments provides an example of the difficulties student-athletes may have maintaining their academic goals. Kim continued to discuss the importance of balancing her athletic and academic commitments as a factor in her enjoyment of her collegiate experience:

> I struggled a lot with my last college. It was kind of hard to balance sports and school because we were practicing so much, but now since I've moved to this university it's awesome. I get to do school work and practice, so my GPA is better and just the change from last year to this year has been awesome.

Kim's account of the transition between schools, and the addition of an athletic scholarship provided her with the financial assistance she needed so that she did not have to seek employment so that she could focus her attention on her academic responsibilities.

The assistance student-athletes receive may influence how they are perceived by outsiders such as the general student population and faculty members. Katie described these outside voices, "Sometimes a lot of the students think we're spoiled. I heard that a lot." She went into further detail about students' comments, "...they [other students] are like you guys get so much help in your schoolwork. Then I try to sit there and explain to them that you guys can go get help too, it's just a lot easier for us to get help, but if you want help there's help on campus everywhere." Kim conveyed a similar sentiment, "A lot of people rag on athletes because we get a lot, but we're also working a lot too." At times, Katie explained that she found herself defending student-athletes because, "…there's some people that don't think student-athletes are very smart, and think that we're just here for the sport and the money and we don't care about the school." However, she also found, "…ones who think that we're really smart because we have some pretty smart student-athletes…" In the face of criticism from outside voices, Katie rationalized, "…there is always going to be disrespect from some sort of group of people towards anything, anywhere you go, so you have to deal with that and just kind of kick it aside …"

Student-athletes' perception of their identity can be shaped by the perceptions of others. Kim explained this in greater detail, "So if I can work hard, and show my teachers that I'm working hard it kind of counters their view if they have a predetermined view about athletes, like how they're slackers or what not. If I work hard in the classroom and I work hard on the field, then everything is good." Kim was not the only student-athlete who attempted respond to the criticism and stereotypes by being a positive ambassador for the athletic department. Diana explained her role as a student-athlete, "Just to represent the program well as far as well-behaved and presenting myself well to other people. Also, putting forth the effort both in practice and competition and in the classroom." Katie described how her and her team attempted to represent the athletic program:

> …we have to set an example in the classroom. We can't show up and be disrespectful because that's showing the athletics are disrespectful towards the professors and towards getting an education. We usually are expected to sit in the front of the classroom, sit up straight, don't fall asleep, and go to class every day. It shows that the student-athletes do care about their schooling, and they're not just here to play a sport and stuff like that.

These accounts give evidence that the student-athletes were aware of how they were perceived on campus, and that they consciously attempted to dispel negative stereotypes through their behavior both inside and outside of the classroom.

Student-athletes expressed concerns regarding how they were perceived by other students or faculty. The student-athletes explained that at times it was easy to distinguish student-athletes from their non-athlete counterparts. Allyson mentioned the men's basketball team, "It's kind of hard to miss them on campus because they're all like 6'-5", you know. People kind of recognize them more, and there's only like 10 of them, versus like the swim team, there's like 60 boys and girls on it." She described how students could determine that she was a student-athlete since she was not 6'-5":

> I know a lot of kids in my classes at the level that I'm at. A lot them do know that I'm a student-athlete, and a lot of time I come from practice so I'm either gross and sweaty or smell like chlorine. They kind of pick up the gist. I don't think I've worn jeans to class ever, just because…no, just because no.

The student-athletes described the "uniform" most student-athletes wore to class. They mentioned often wearing sweat pants to their classes. From the observations of the College Algebra and pre-service elementary mathematics classes, often student-athletes who wore backpacks with their team's insignia on it wore sweat pants to class. Diana explained her choice of clothes may keep students from identifying her as a student-athlete, "I don't think most people know that I'm a student-athlete because I wear normal clothes; I really don't wear all the team gear." The student-athletes reflected on how their clothing may influence how they are perceived by other students. Shelley thought, "Maybe they think we're stuck up because we wear sweats every day." Kathleen explained, "I think some of them perceive me negatively because I'm out of class a lot or struggling to stay awake or wear sweatpants every single day. For the most part they all think it's kind of cool."

Perception of Mathematics

In order to understand student-athletes' cultural relationship with mathematics it was necessary to explore student-athletes' individual perceptions of mathematics and how these perceptions developed; thus, student-athletes were questioned about their perception of mathematics before asking about how other factors such as their authority figures or educational experiences influenced their perception so the student-athletes could explain their perception of mathematics untethered to any bias or prompting from the questions. This allowed for follow-up questions about any influencing factors not documented in the literature, as well as asking the questions regarding the influencing factors found in the literature.

Low amount of mathematical experience. When asking a group of people about their perception of mathematics, it can almost be expected to find at least one person, if not more, that will voice their aversion for mathematics. Therefore, one may assume when asking a group of student-athletes with low amounts of mathematical experience to perceive mathematics there will be at least some negativity. Paul expressed his own perception as he discussed his difficulties with mathematics, "I see mathematics as…you have to be able to understand an equation or you're going to get everything wrong. That's where I get things wrong." He continued:

> I'll go through a formula or a problem, and I'll miss a step. You miss a step, you're gone. You got to do it all over. That's what frustrates me about it, having to actually take so long on one specific problem. That's where it gets me, because I just want to move on to the next one.

Paul mentioned that his motivation to move through obstacles quickly carried throughout other aspects of his life, but with "…math, when I miss a step I have to go back over it three times, and be done with that problem 20 minutes later. That's what I see as math in my eyes, just the difficult times that I've had going through problems." These difficulties have presented themselves in his grades in mathematics as well, and as Paul described how these experiences influenced his perception of mathematics:

> You know with athletics you can't really afford to get too many D's and F's. Getting a, I think it was a C in a basic algebra course, a D in another one. It's just like 'Ughh, that's disappointing.' I don't like getting bad grades of course, who does. That's the only discouraging part of it was the outcome that I had at the end of it.

Shelley echoed these sentiments:

> There's concepts that I just can't grasp, and I think that the ones that I can't grasp I just dislike so much. The ones that I like are the ones that I understand. No one wants to do something that they're bad at. I think that's how I feel with math as far as math concepts.

She added, "Overall, I like math if I'm good at it. If I'm bad at it, and I don't understand it I just want to throw in the towel." Both student-athletes expressed their desire to discontinue or avoid mathematics due to their prior struggles with mathematics.

Student-athletes' previous experiences with mathematics was not the only source of negativity in their perception of mathematics. Adam explained:

> I feel like some of the stuff you learn is impractical, but at least I don't feel like I'll ever use it. When you get into the higher level, like different occupations, you might end up needing your calc, your trig, or stuff like that. I don't necessarily see the relation to my life style. I took trig and stuff in high school, but I don't think I've used that in my daily life. Cosine…I don't know, it might be behind the scenes or something, but I never have to physically use these formulas. Sometimes I think math is just a burden, it can be busy work.

He continued, "I like it when it's more problem solving, because I do relate that to real life. I like in a way the challenge of it, and then sometimes I'll be fed up with it and be like, 'I'm never going to use, I don't need to know this formula and practice it a hundred times.'" Adam's response suggests the influence that a student's awareness and understanding of applications of mathematics may have an effect on their perception of mathematics.

There were student-athletes with low amounts of mathematical experience possessed little to no aversion to mathematics. Stewart discussed the enjoyment he found in mathematics:

> I think it's challenging and fun at the same time. Sometimes it can be overwhelming and tough, but when you become able to understand a problem, be able to work stuff out I think that's fun when you can work out a problem. You can go down, follow the steps to its conclusion and find the final answer.

He went on to describe his high school mathematical experiences as shaping his current perceptive of mathematics, "Doing stats and probability and that kind of stuff. After going through all that I kind of like that it is challenging and tough, but it's fun when you can finally catch on to the concepts and what not, and finally come to the conclusion when you're right." This gave support to the idea that success in mathematics may affect how students' perceive mathematics. Additionally, there was a similarity in student-athletes' enjoyment in overcoming challenges stemming from both of their dual roles as a student and an athlete, as well as from their interaction with mathematics. Jenna expressed a fondness of mathematics and the pleasure she experienced as a result of her interaction with mathematics, "I really love math. I always get really happy when I get a question right or solve a problem." She continued by describing her earlier mathematical experiences:

> I only really started liking math in grade nine because I was the best in my class at math. I had the highest A, my average was 97. I don't know, it was just like fun being the smartest at math. I sucked at pretty much every other subject, but math

> was just the best. I was recommended for Math AP, but I didn't pursue it in high school. Then I was teaching all my friends. It just made me feel good.

This gave evidence that student's prior mathematical success may serve as a predictor for how they perceive mathematics. Jenna expanded upon on her interactions with mathematics, "…with math I don't like being taught it, if that makes sense. I like teaching myself." She detailed her preferred method for engaging in mathematics, "…I love doing on-line math. I did on-line math all through high school. If I see an example, I take it step-by-step and teach myself how to do it. I find that most effective." Again Jenna cited her satisfaction in learning mathematics "step-by-step" in her university mathematics class:

> My math teacher is really good. He does everything step-by-step. I pay attention, but when I go to do the homework, because the homework is on-line, it gives you steps and examples, and then I just take that and that's how I get it. It helps you memorize, I guess, every step teaching yourself.

Jenna was not the only student-athlete to bring up their mathematics professors when asked about their perception of mathematics. Paul, whose negative perception stemmed from his poor mathematics performance, discussed mathematics in a positive light as he talked about his former mathematics professors:

> I can say that every math professor that I've ever had has been extremely helpful here. I know that they have a lot of helpful facilities here, which was also nice to know. I go down to the math tutoring, down there on campus. There's people there, I think from almost eight in the morning to eight at night, so you can go anytime you want. They're just sitting down there, you pull out your notebook, tell them what class you're in, and they just start helping you with your homework. My professor was actually the person who ran the math tutoring over there. He was a great guy. He was willing to help me. He knew I was struggling with the class after the first exam. I told him that I need help or I'm not going to make it through this class. It was a lot easier for him to say, 'Just slow down and finish this part first. We'll move on to this part next. We'll get this question done in eight minutes instead of twenty. We'll do it right the first time.' I learned from him to slow down and take my time on questions that needed to be taken time on.

Moderate amount of mathematical experience. As one might expect, students who have engaged further with mathematics have a more positive perception of mathematics. This perception does not necessarily reflect the student's mathematical competency. Kathleen expressed, "…I love math. I'm just not any good at it." She then explained why she didn't consider herself to be good at math, "It was something that I worked really hard at and I never understood or I thought I understood it and I got into the tests and just fail or not fail, but not do well." This did not prevent her from finding mathematics appealing though, Kathleen continued, "I think it's really interesting and I like that there is only one solution. The solving method is cool." When asked what about the solving method she liked, Kathleen replied:

> I don't know. I'm a dork I guess. Knowing what steps…like when you have to prove different equations, I like that because there was a problem and you knew how to fix it and it was going to take different methods and you just had to play with it…it's kind of fun. You also know that you will find a solution, and once you do it's kind of like a good feeling.

Again, a student-athlete described their pleasure in overcoming a challenge.

The importance of positive working relationship between student-athletes' and their mathematics instructors was evidenced through Katie's description of how her perception of mathematics was altered. She explained:

> I loved math until I took calculus here. I did not enjoy calculus. My teacher, you couldn't understand a word he said. He taught straight from the book. I can't learn straight from the book. If I missed class in high school, then they gave me the book, I couldn't learn it. I had to learn from the teacher teaching me. I feel like the teacher was just writing straight from the book, he didn't really teach.

Katie's perception of mathematics seemed to be influenced by what she saw as a hindrance in her learning of mathematics, and from her account of her Calculus I experience; it appeared that she saw her professor as the primary source of this hindrance.

Similar to Kathleen's mathematics experience, Katie seemed to find mathematics enjoyable until she encountered an obstacle in her learning which she could not overcome; which both sited their teachers as a contributing obstacle. This increased emphasis on their mathematics teachers may stem from the fact that their increased amount of mathematical experience exposed them to more teachers that use different techniques for teaching; some of which they found problematic with their learning.

Fortunately, Katie's experience in her Calculus did not change her entire perception of mathematics; she explained that her perception changed, "Just on calculus." She continued:

> Most other math I enjoy, like if one of the other girls on my team has problems with algebra or geometry then I'm always telling them that, 'I'll help you. I enjoy doing math, just let me know if you need help, and I can help you with it.' Usually they come to me, sometimes I can help them, but sometimes I'm like, 'You might want to go to see your teacher on that problem because I don't want to give you the wrong direction on which way to go.' I enjoy doing math a lot.

Katie's positive attitude toward mathematics contributed to her supporting her teammates in their own mathematical experiences. This may help promote a sense of camaraderie as Katie and her teammates work together to achieve success in their ventures within the mathematics community.

While student-athletes have shown to enjoy taking on challenges, Katie and Kathleen demonstrated that there are limits to which they would struggle with mathematics before pursuing other interests. Both student-athletes decided to end their engagement in mathematics courses after completing Calculus I. However, Calculus I was not a barrier to pursue mathematics further for all student-athletes. Diana, a freshmen chemical engineering major, enrolled in the university with credit for Calculus I and II;

beginning her university mathematics education in Calculus III. When asked about her perception of mathematics, Diana explained:

> I like it because it makes sense. You can work through things to find an answer, whereas with a language you have to look up a definition or try to find the right words, which is kind of hard to do for me. With math you can just kind of reason your way through things as soon as you learn a few base things. I love how it all builds on itself, it gets bigger and you can do more and more and more.

Diana's thoughts on mathematics and her reasoning for enjoying mathematics diverged from those of the other student-athletes with low and moderate mathematical experience. The other student athletes cited characteristics in the problem solving process of mathematics to account for their liking of mathematics, but Diana showed an appreciation for the structure of mathematics and the ability to continue building toward bigger ideas in mathematics. Diana also displayed a level of awareness of mathematics as she described her perception of mathematics, "I think it's a way that we can describe the world, we can describe the world through numbers…I just like it." When asked for examples of how she saw mathematics in the world, she explained, "…when you talk about a group, you think of how many people are there, how tall people are, how small people are…um…prices a lot, percentages of things…I don't know, I just think there are a lot of numbers all around us besides all the technology."

When comparing the perceptions of mathematics for the student-athletes with moderate amounts of mathematical experience, there was a distinct difference between Katie's and Kathleen's appreciation for mathematics and Diana's. One contributing factor that may account for this difference was Diana's increased exposure to mathematics, in particular her enrollment into Calculus III which focuses on examining multi-variable calculus that allows for richer real world applications than single variable calculus.

High amount of mathematical experience. Examining student-athletes' perception of mathematics through a progression of their mathematical experiences provided a sense that their understanding of mathematics transitions from following a series of steps to considering how these steps may aid in solving a problem to using reason and logic to build from basic concepts. This transition continued with student-athletes possessing high amounts of mathematical experience. Student-athletes' appreciation for and depth of understanding of the scale of mathematics increased; this was evidenced by student-athletes' perception of mathematics. Allyson described her own thoughts on mathematics, "It's just when you break it all down, and think about behind all of the algebraic equations and the unit circle and stuff like that there is so much…I don't know, I just think it's sweet how it all works out and how people discovered how it all works out. It just kind of blows my mind." Allyson demonstrated that her perception of mathematics went beyond the process level of solving problems that many of the student-athletes with low or moderate amounts of mathematical experience by also considering the structure of mathematics and how mathematics "works out". Additionally, Allyson's response hinted at her fascination with mathematics. Kim possessed a similar enthusiasm for mathematics and its applications. She explained her view of mathematics:

> …it's essential… I'm sure another major could say this about their own major, but with math you get, you're well-rounded. You have to know how to write a proof, so that's English. You have to know how to do that process, which is another process of thinking entirely. You have to be abstract about it. Then you have…I don't know, I guess it just strengthens your brain.

Kim perceived the connections other subjects have with mathematics and how mathematics influenced her thinking. She went on to detail how mathematics "strengthened" her brain:

> …I took a discrete mathematics class and an abstract algebra I class, and the first time I took those classes, I was like, 'What? I don't know this stuff existed.' I didn't know things besides 1+2, and so the ways that it opens your mind that there's other concepts, it's infinite, stuff is infinite, it can go on forever and ever. I could sit there and think about the processes of completing something, and it's just crazy. Math is like that, life is like that, life is crazy…there's many routes you can take, and that's the same in mathematics.

Kim's and Allyson's experiences with mathematics appeared to have a similar effect on them. From talking with these two, there is this sense that they felt that their exposure to mathematics affected their brains, or at least how they think, in particular with their abstract thinking. While both student-athletes used phrases such as "It just kind of blows my mind" and "it's just crazy" to describe mathematics, the context in which they used these phrases suggests that Kim and Allyson saw mathematics effect on their brains as a positive.

While both student-athletes with high amounts of mathematical experience discussed the ways in which mathematics influenced their thoughts, there were still some similarities in perceptions with the other student-athletes with low and moderate amounts of mathematical experience. Allyson described her view on problem solving in mathematics:

> …my favorite part is that there is only one answer, which can be so frustrating, but when you actually get it, it's one of the most rewarding things. Knowing that if someone else in a different country did that same problem, they still get that same answer, I like that. That's what I think is beautiful about it I guess.

Kim reiterated this appreciation for knowing there is a definite answer in mathematics, "There's always one right answer, but the way you get to that one right answer can be different." This suggests a common thread of valuing the objective nature of mathematics by student-athletes, no matter the amount of their mathematical experience. However, as student-athletes increase their mathematical experiences there was evidence that their appreciation for mathematics deepened. Allyson explained that she saw beauty in mathematics, while Kim noted how she was able to connect mathematics to other subjects. Even with these differences between student-athletes with varying levels of mathematical experience mathematics can become frustrating for all student-athletes, as Kim pointed out, "It's like a love/hate relationship sometimes too, because sometimes your math classes hate you."

Influence of Mathematics Education Experiences

One construct studied was how student-athletes' educational experiences may have contributed to their perceptions of mathematics. The examination of the student-athlete interview data resulted in the emergence of themes which described various factors that may influence student-athletes' relationship with mathematics. One such theme that emerged was how student-athletes' prior mathematics education experiences shaped their current perceptions of and engagement with mathematics. These educational experiences can be a deterrent, as Katie expressed, "I loved math until I took calculus here. I did not enjoy calculus." However, student-athletes' prior experiences in their mathematics education can be a catalyst, as Kim recounted, "…I took a discrete mathematics class and an abstract algebra I class, and the first time I took those classes, I was like, 'What?' I don't know this stuff existed, I didn't know things besides 1+2…" The following discussion offers a focused examination of how student-athletes' mathematics education experiences contributed to their relationship with the mathematics culture.

***Low amount of mathematical experience*.** It is natural to expect that student-athletes with low amounts of mathematical experience would have little to draw upon regarding how their mathematics education experience influenced their relationship with mathematics. However, when these student-athletes discussed their mathematics education, their reflections provided insight into their interactions and engagement with the mathematics culture. Shelley recounted her experiences from her mathematics class, “I sat in the very back, so it was really hard for me to see the board. I should’ve probably moved to the front, but…I was really intimidated by my teacher.” She attributed some of her intimidation to the setup of the class:

> …with a class of like a hundred people it’s…it’s just weird, you know everyone says that a stupid question is a question that’s unasked, but with a class of a hundred people I felt like it was almost that everyone knew besides me, but I know that probably was not the case.

Shelley also found issue with her instructor, “…it seemed the teacher was talking down to us, it made me feel that way, so I never wanted to fully ask a question or raise my hand in the class and say that I don’t understand.” This led me to ask if she thought her instructor provided reasoning behind what they worked on in class, she responded, “Rarely. Rarely they do. When they do it’s…it’s kind of like I want them to go on into more depth, but they just stop right before I fully understand the concepts. It’s kind of frustrating. It’s like you get to the door, the door starts opening and then they close it.” From these experiences Shelley described mathematics as,

> …a mystery. It’s like, you know how I said that I like learning about a lot of things, but then when it comes to math I don’t really know what’s going on. It’s

> like I don't really want to know, but I do. It's something that I just don't really understand. I don't have a math brain I guess.

These different stresses resulted in Shelley enrolling in subsequent mathematics course on-line, commenting, "…it's easy because I don't have anyone seeming condescending." Her reaction to her negative experience with mathematics contributed to her notion that mathematics was a subject where only those with natural abilities succeed and the rest struggle.

Shelley's experience provides evidence that the stress student-athletes experience in their mathematics education can influence how they interact with the mathematics culture within the university. Thus, there was a need to examine what about the student-athletes' mathematics education they found to be most stressful. As one may expect, student-athletes found their mathematics exams to be a source of stress. Shelley explained:

> Sitting down at a test and not knowing what the heck is on the paper. I don't know…that's how I felt when I did my probability exam. The first time it was just like, 'What am I doing right now?' I don't know, I hate not knowing what the answers are or even how to figure it out.

These feelings were not isolated to just exams for Shelley; studying also brought out comparable responses, "When I would study I would be like, I don't even know what this is." Jenna discussed the reason for her stress from problems involving abstract variables, she explained, "I'm never going to use this ever…" and "It's not like in your basic day-to-day life to be solving something like that." Thus, Shelley's and Jenna's mathematics education experience suggest that different types of negative attitudes can arise from the same stressor. Shelley's anxiety stemmed from her feeling of being lost in the content, while Jenna's frustration came from her perception of the presence of mathematics in her life.

The stress Paul experienced from his mathematics exams was still different from the other student-athletes. Paul compared the type of questions he answered on his communication exams to that of his mathematics exams. He explained the format of his communication test:

> I have my communication test, it [a question] is a sentence and it has A, B, C, or D. That's going to take 30 to 45 seconds max and you're going to circle one answer, and it will probably be a vocab term out of the book. If you read it, you know it.

Then Paul reflected on his mathematics test:

> On the math, you get a big packet, and it can have number one on page one. You flip it over, and two and three are on page two. So you're going to be taking more time. Like I've said, I've grown used to circling A, B, C, or D. With math you have to read the problem, probably two or three times, to where you actually know it word for word…

Paul expressed frustration working through problems on his mathematics exams, "…it's a lot more frustrating to answer a math question when you have to go through so many steps to find the answer, versus a communications test where you just circle it." He recounted his experiences, "Sometimes when you know it, you're like, alright, let's do it. Step 1, 2, 3, and 4. Write down, there it is, and you find the answer exciting. If you don't know it because you got the wrong formula cruising through your head, you're like, 'This is frustrating because I know the formula is one of these three. And it's just like, I don't know which one it is, so I'm going to go with this one.'"

Paul provided further evidence of student-athletes channeling their competitive nature into their academics. He first described his competitive side:

> …with me completing a task that is difficult gives me great satisfaction. I probably wouldn't be a Division I athlete if I didn't like to beat the best. Otherwise, I wouldn't be here. I would be in DII or DIII, if I was okay losing to the best. I want to strive to be the best and beat the best.

Paul then explained how he applied this mentality to his mathematics education:

> So with math, it's like you get satisfaction because for me math is like a tough opponent. It's tough for me, I can't conquer it like other things. I feel like I need to conquer everything if I'm going to be the biggest, strongest, best man in the world you know. It's like there's a math problem in front of me, and I need to know how to conquer it or it's going to beat me.

He then connected back to finding satisfaction in overcoming the stress he experienced during his mathematics exams:

> It's very satisfying when you're able to learn a problem and you get it on the test. You're like, 'I'm going to kick the crap out of this problem' because you know it, and that's satisfying that you're able to learn like that. I feel like it pays off once you put in the work because you're not going to leave a blank answer there, you're going to write it all down.

Again, the theme of student-athletes placing work ethic in high regard, and acknowledging the rewards they earn for their effort is present.

While these student-athletes with low amounts of mathematical experience found stress and satisfaction from the trials and successes of their mathematics education, there were also student-athletes that found satisfaction from how their mathematics education changed their perspectives of mathematics. Stewart explained how the way in which he perceives mathematics changed from his experiences in his elementary mathematics courses:

> …when I look at $5 - 3$ as a problem, I know it's 2. But now with the elementary education, I know how to look at it from kid's point of view. So I think that's where it's changed. I can't always just think my way of thinking, you have to think about the way other kids are thinking too and how they're going to be able to come up with the answer to that problem. Not just looking at it and saying 2, 'How are they going to figure it out?' I think that's how it's changed for me.

He went on to explain how this change in his view of mathematics brought him satisfaction:

> I would say that is satisfying too because sometimes you do need to change your point of views. You can't act like you know everything. Sometimes it brings you back a step. I think overall in life, you need to slow down and look at it from another person's point of view. The same thing goes with teaching little kids math. You might understand it, you can look at two numbers and find the answer, but that little kid may not be able to. I think it's satisfying to look at different perspectives on math or maybe anything that you come in contact with in life.

Adam's experience in his elementary mathematics education coursework brought him a similar satisfaction:

> I get another satisfaction from knowing that…finally when you have a troubling problem, like how did this kid get to it…figuring that out is pretty satisfying, like, 'Now I get his thought process.' Seeing…they can show you some stuff and I'm like, 'Wow, that's pretty unique. I've never seen it done that way.'

He went on to explain his thoughts in greater detail:

> Seeing what these kids can do, 'Well that's pretty neat, he did it in his own way. He created his own algorithm for this problem.' I never would have thought of it that way because I think as you get older, especially into high school, you just get these formulas jammed into your brain, 'This is how you do it. This is how you do it.'

Adam's discussion concerning the satisfaction he found from seeing how children could create their own methods for solving mathematics problems seemed to reflect the frustration he expressed earlier regarding having to work through mathematics through a preset, formulaic approach. He added, "In the lower level math, you can count anyway you want. If you want to do base 10 or base 4 blocks that's all you. I think that's one thing that is pretty cool and I like to see."

Moderate amount of mathematical experience. Similar to student-athletes' with low amounts of mathematical experience, those with moderate amounts of mathematical experience also found exams to be a major source of stress in their mathematics education. Kathleen described her stress, "…knowing the exam is going to be nothing like what we've done in class. That's a pretty consistent theme throughout all my math classes, even from high school." She went on to explain the differences she noticed in detail:

> The questions that we go over in class I can answer fine, and I don't really have an issue with. They're all really similar. Then as soon as we get to the exam, it's completely…not completely different, but there's a couple of things that we never even touched on…different aspects of a problem that we never really learned how to deal with.

Katie expressed similar concerns about the source of her stress, "The testing. Definitely the testing. The homework wasn't too bad because it was very easy problems, and then you get to the test they throw the hardest problem they can at you so that they make sure that you understand it before they move on." Even though both student-athletes found the differences they perceived from the problems they encountered in class and on their homework to the problems presented on their exams stressful, this stress influenced each differently. Kathleen explained how she was affected:

> I think that's been really stressful because you never really know how to study for math either. I think it's also been stressful when you don't understand it, and I would get tutors from this place [Academic Support Services] or I would go in to see my professor, and no one was really getting through to me what was going on. That was really stressful, not knowing how to help myself at that point.

While the differences between coursework and exams created a sense of being lost for Kathleen, these differences triggered a change in Katie's understanding of mathematics:

> …that transition from easy problems in homework to being thrown a harder problem was very difficult for me, but I finally got it because I learned that you have to understand the concept of the easier problem to understand the problem, you can't just memorize the problem, which is what you could do in high school. It's a lot more conceptual.

Thus, there is evidence that placing stress upon student-athletes can have contrasting results.

The competitive nature of student-athletes presented itself throughout their athletic and academic identities. There were various instances documented where the student-athletes reveled in overcoming a challenge or obstacle. This theme emerged once again as Kathleen discussed where she found the most satisfaction in her mathematics education, "I think realizing what a poor foundation I had in math, and I was still able to make it through some higher level math classes has been kind of satisfying." She described her satisfaction further, "I think it was just satisfying to know that despite that I was still able to not completely overcome it, because I still got stuck, but to overcome it enough to keep going in my math classes and to understand what was going on better." Kathleen's statements and accounts of her experiences with her high school mathematics classes suggest that she acknowledged the importance of a strong mathematical background in succeeding in certain academic fields. While Diana's and Kathleen's satisfaction stemmed from the sense of competition and success, Katie found satisfaction from relating her mathematical knowledge to her identity as a student-athlete and daily life. Katie connected her work in mathematics to her athletics competitions, and found the applications of mathematics to be the most satisfying aspect of her mathematics education. Katie explained, "…being able to apply it to things we do in everyday stuff. Especially in my sport, if you think about it, it's all…technique is all math and body muscles and science…it's all math and science. Most everything you do is math and science." Note the difference between what Katie found satisfying about mathematics and Adam's perception of mathematics, "I don't know, it [mathematics] might be behind the scenes or something, but I never have to physically use these formulas." or Jenna's feeling that mathematics "…is not like in your basic day-to-day life to be solving something like that." This difference may be due to Katie's increased exposure to mathematics, aiding in her awareness of mathematics surrounding her. The applications of mathematics within course content of Katie's Wildlife Biology & Fisheries Management major may also account for her enhanced mathematical awareness.

The additional mathematical experience student-athletes with moderate amounts of mathematical experience possessed, in comparison to their peers with low amounts of mathematical experience, allowed them to examine their experiences for instances or circumstances which they view as influencing how and with who they engage in mathematics. Katie recounted differences that she observed between her high school and university mathematics education, "They [her high school mathematics teachers] didn't teach from the book. They wrote their own notes and broke it down a lot." She explained her teachers' reasoning for their teaching practices:

> A lot of the kids in that class that's the highest level math they're ever going to do so they needed to break it down a lot more for them, so that helped with me because if you could break it down enough for me I can understand it, but if you skip a bunch of steps in between I'm like, 'Oh, where did you go?'

Katie then created an analogy between how she learned techniques she used within her sport one step at a time and how she learned mathematics in high school through a step-by-step process. She described the conflict this caused in her mathematics education, "I guess it's always been built into my head that I can't skip steps so it's hard for me to sit in a classroom where they do that, and that's what happens in college versus high school." When asked if she ever stopped her professor to ask questions, she responded, "I did, and sometimes he would explain it, and then he would keep going. He wouldn't make sure that I understood it. He would kind of write down the step, and then keep going." She went into further detail, "It was kind of confusing because I was like, 'How did you get that?' Sometimes he could explain it, but sometimes he was like, 'That's just how it is.'" Katie then explained how she perceived the structure of mathematics, "…it [mathematics] is not like science where you just accept it, there's always a way to get to something in math, there's always that basic line." This suggested that Katie felt that the step-by-step practice of teaching mathematics she experienced in high school was more conducive in revealing the reasoning behind the mathematics. Katie's interactions with her professors caused her to seek out a tutor to aid in her understanding of the mathematics.

Student-athletes' experiences in their mathematics education not only influenced how they engaged in mathematics, but influenced their perception of mathematics. Kathleen explained how her perception changed:

> …I'm really big on work ethic and working hard and stuff. I do kind of think that with math, and with every subject, some people are just better at picking it up than others. Because of just how hard I would work at it and not get it. I think that perception has changed, that it's not just work, that it's kind of also having a good foundation in the past and having a grasp or it beforehand.

Her changed perception that being successful in mathematics required some innate ability that hard work would not allow her to overcome followed Shelley's idea of her needing a "math brain" to do well in mathematics. This suggested that both student-athletes perceived those who successfully engage in mathematics as being different from them. Examining Kathleen's response further, the frustration of not being able to rise to the challenge that mathematics put before her was great enough to reshape her perception of what hard work can accomplish. Thus, provided additional evidence that student-athletes' appreciation for overcoming obstacles had limits.

High amount of mathematical experience. While student-athletes with low and moderate amounts of mathematics education experience found reasons to cease their engagement with the local mathematics culture, student-athletes with high amounts of mathematics education experience chose to engage further with the local mathematics culture. Kim explained the high amount of mathematics that she experienced at one time that created a great sense of stress, "One year, we had to take…just to kind of push us all through the math degree, or math classes, we had to take four [mathematics courses] in one semester." She described her experience in further detail

> …everybody was learning this stuff and then forgetting, shoving it out the door, because there was so much material that you had to chew through to even understand anything. The classes kind of related, but they didn't, but the next semester everything built off of what we tried to learn the semester before.

Kim suggested that this set her up to have a weak foundation for her following classes as she discussed having to learn the material, and then forget so that she could stay on top of her other mathematics courses. She also reflected on how these experiences with mathematics differed from her earlier mathematics coursework:

> That was hard, just the process, the speed you go through stuff. I don't know, in calculus you get this long leisurely time to do Calc I, Calc II, and Calc III, and then boom they hit you when you have to do Algebra I and Algebra II in the same semester almost sometimes. It's crazy, just the concepts…graph theory and number theory, and you're like, 'What?' It's like spinning in place. I think that's the only drawback, you get set up like, it's okay, math is kind of slow paced, then all of the sudden your slammed, not any more, no such luck.

Allyson's stress from her mathematics education experience did not stem from an overwhelming amount of mathematics, but from a singular source from her mathematics education. She described the origins for her stress from her mathematics experience, "I think one of the most stressful things has been professors…" She went on to give an example of how her professors caused her stress:

> …I took a class, this is just an example but it's a pretty good one because it was stressful. It was polynomials, so there's no book that goes with it, right. It's kind of up to the teacher's interpretation as what they see as is important and what they think everyone should learn. My professor was the really smart mathematician, but had a really hard time teaching it.

Allyson explained the atmosphere in the classroom and structure of the course:

> My classmates and I were all struggling, so we would help each other out a lot, but a lot of times we were literally shooting into the dark to find something. It's not like you could even pull up a book to try and help you because it was so based off of what he wanted you to know and what he told you in class.

She continued to recount what she found difficult about working with her professor:

> That was kind of hard because I had always been used to classes where if I didn't understand something I would go to the book and I would figure it out myself or read through that and figure that out or try to find something on-line that would help explain it, but because this class was so specific to what he [her professor] wanted us to learn it was really hard to find anything on it.

This instance in Allyson's mathematics education experience resulted in her coming to a similar realization as Kathleen when she discussed her mathematics education experience. Allyson explained, "I would say that was stressful, just kind of how some of the content bites you if you're not prepared for it." Allyson's athletic commitments made the class even more difficult, as she explained "That was the hard thing of it. I had practice whenever he had office hours, so I couldn't go in and see him." However, when she scheduled appoints with her professor, Allyson described the experience:

> I did once, and it did not go very well. He was, he was a stubborn teacher. He was just kind of hard, because in class even he would tell us that he wanted us to ask questions, but whenever someone would ask he would tell us that this is simple

> arithmetic. I don't know why you're not getting this. We're like, 'Whoa. Bro. Okay, we're just learning this stuff.' That was kind of hard. It got to the point toward the end of the class that no one was asking any questions because it was frustrating to have him yell at you about how dumb you are.

Allyson's description of her experience with this mathematics professor seemed to play out like a more abrasive version of Katie's experience with her Calculus professor. Both student-athletes suggested feeling somewhat a lack of instruction from their professors, and like Katie, Allyson sought out others to engage in the mathematics, "I just resorted back to, okay, I'm going to use my classmates, and we're going to figure it out collectively. It might not be the best method, I probably should have still tried to go in, but I didn't." Even realizing that avoiding her professor was not in her best interest to succeed in the course; Allyson chose to rely on building an understanding of the material with her classmates because she felt more at ease with them, and they helped her to make it through.

Allyson's experience provided further evidence that student-athletes' mathematics education experiences influenced how and with whom they will engage in with the local mathematics culture. While negative experiences with individuals in the mathematics culture were a source of stress for student-athletes, their positive experiences with individuals in the mathematics culture brought a sense of satisfaction. Allyson recounted working through mathematics with her fellow classmates, "…I don't want to say bonding, but going through these hard classes with my classmates, and then having classes with them next semester and being like, dude, we survived that, and now we're going to take this one." Allyson's response suggested that her classmates are analogous to her teammates as they worked together towards a common goal of being successful in their mathematics courses. She also described the benefits of having her classmates to discuss their similar interests and struggles:

> I think it's been cool to have people around me who love math just as much as I do. We're learning difficult concepts in class, and yeah it's kind of confusing at first, and then you get done with a lesson and you're like, okay, my mind is kind of blown, but that was really interesting. Everyone else kind of shares that view. It's not just you, and everyone else is like, that was stupid.

These bonds Allyson developed with her classmates seemed to help eliminate a sense of isolation through the formation of shared experiences and ways of thinking. She explained the connection she developed with her classmates has been a source of support and satisfaction, "It helps too, because then even if the material is hard, the fact that you're interested in it helps. That's really been, I don't know, it makes me feel satisfied…"

While Allyson found satisfaction in working with her classmates towards the common goal of understanding mathematics, Kim reveled in the act of understanding mathematics itself, she explained, "I think the struggle to understand something, and then getting it once you're sitting there." Kim's described her early struggles with mathematics:

> I had to take a class over two times, well three times but I dropped out…it was kind of a crazy year, last year. I had to take discrete math over, and the first time I took it, I just blew through it and I wasn't even there for class like half the time because we were traveling, it was second semester. I got a D in the class. Then the second time I took it, I dropped out of college.

The challenges Kim experienced of pursuing her mathematics degree and being a student-athlete resulted in her removing herself from school completely. She discussed her initial experiences with mathematics after transferring to her current university:

> This last time I took it, I finished the half of the semester that I did here and I kind of did it through a self-taught kind of thing, but I guess that struggle from not

> understanding what the heck is going on in class and all of the sudden that ‘Ah-ha moment’ where you get it and you feel like you’re the queen or king of the universe because it was so hard to grasp and all of the sudden you’re like ‘Yes!’ and you never forget it.

Kim’s immense satisfaction from gaining an understanding of the mathematics may stem from knowing the sour of struggling before knowing the sweet of success. She continued to talk about the shift in her understanding, “Once you fully understand it and get it, it sticks with you. I could talk about graph theory all day long, and they wouldn’t know what I was talking about, but that is the most satisfying thing.” Kim also found satisfaction in feeling that she accomplished something that not everybody can do, “Just understanding that not everybody gets this…that’s really rewarding.” She went onto to express an appreciation for the scope of mathematics as a field of study:

> …I can look at my transcript and be like ‘Yeah, I’ve taken 20 plus credits or classes math.’ It’s crazy, I didn’t even know coming into college that there was anything beyond calculus, so I was like, ‘Yeah, I got this in the bag.’ Its nuts. I think that’s the cool part, there’s so many aspects of math you can’t even wrap your head around. It’s infinite.

Thus, Kim provides additional evidence of a student-athlete that continued to work through challenges, and in Kim’s case of extensive struggles, to find satisfaction in the fact that their hard work produced positive results.

Influence of Support Systems

The analysis of interview data with student-athletes revealed an emergent theme which provided evidence of where student-athletes were finding encouragement, advice, and support for engaging in mathematics. Student-athletes’ support system were defined as their peers, teammates and other supporting personnel as it relates to mathematics. As the student-athletes discussed their choice of major and perception of mathematics, student-athletes mentioned how an individual or a group, whom had little sway in relation to the student-athletes' athletic or academic responsibilities, would support their interests or pursuits in mathematics.

As earlier discussed by the student-athletes and members of the athletic department staff, student-athletes had access to multiple levels of support for their mathematical pursuits. These support systems included modes of support that all students have access, such as a mathematics tutoring facility and peers; however, student-athletes received resources which the general student body had no access, such as the athletic department funded Academic Support Services. The differences in avenues of support that student-athletes had from their non-athlete counterparts contributed to student-athletes distinct culture within the university.

***Academic Support Services*.** One major difference in the types of support student-athletes received in comparison to the general student body within the university was access to Academic Support Services operated through the athletic department. While it may be argued that this addition of the Academic Support Services main function was to serve to aid their student-athletes' academic pursuits, Abe, the former head of the Academic Support Services, countered, "Any Division I program that tells you they built the academic center for their student-athletes...it's unique." He explained:

> In your major BCS conference schools, the reason why they build these huge academic centers...The one at a large football university I think is like 50 million, the one at another large football university is maybe 125 million. They do that because it's a recruiting tool. When you bring parents in that environment, you show them everything you can do academically. They have so much money and capital, it doesn't matter. They can build a 500 million dollar program if they wanted to, but they do it for the recruitment piece.

Abe acknowledged that no matter the reasoning behind an athletic department's decision to provide an academic service component to their student-athletes, it still allowed for individuals such as himself the ability to get involved in improving student-athletes' education.

When asked the student-athletes about what assistance the Academic Support Services offered for the student-athletes in their mathematical pursuits there was a common response, tutoring. Julia, the tutoring coordinator for the Academic Support Services, explained the hiring requirements for tutors:

> …they need to be upper classmen, so they need to have earned at least 60 hours, and they need to have a cumulative GPA of a 3.0. We have our job posted on the HR site, but my preferred way of getting tutors is from recommendations from faculty. I'll ask them to recommend people that they have had in their classes before.

Some of the student-athletes recognized the competence their tutors brought with them. Katie described her experience with a tutor:

> One of the tutors here, I don't remember his name, but he tutored almost everything, and he was so smart, and he wasn't even my tutor, but sometimes I would just go up to him and be like, 'Hey can you help me for like 30 minutes?' and he was unbelievably smart about breaking down an equation. I've never seen it done the way that he's done it before, and I told him that he should teach math because he did it amazing. They bring in amazing tutors for us to have so that's always nice.

Paul described the process to find a tutor within the Academic Support Services:

> If I come up here and I'm struggling with math, I'll go into the offices and I'll be like, 'I need a tutor this week and this week and this week.' You make a calendar with them [Academic Support Services staff], and they're on the phone tomorrow hiring a tutor for…if it's Monday, and say you need a tutor before Friday or whatever. They're on the phone Tuesday, and you have a tutor there on Wednesday or Thursday. It's a really great system over here.

In addition to setting up a scheduled time to meet a tutor, Paul mentioned that the Academic Support Services, with athletic funding, will hire tutors that offer walk-in help. He described these open schedule tutors, "I've seen people [tutors] at the tables over there, sitting with their computer, with a sign on it that says 'Math Help' or 'I'm a math helper'. If you need help with your math, just come sit down." These open tutors were present in the observation of the Academic Support Services. They would position themselves at either group study tables or within one of the private tutoring rooms with a sign advertising their presence so that the student-athletes could find them easily. This ease of access to tutors was brought up consistently among the student-athletes as well. Stewart explained:

> I haven't needed a tutor for this class, but if I ever needed a tutor they would…I would easily have one. I know they have good tutors here. One of my tutors I have for astronomy class, who is also a math tutor, if I ever needed help he would always come and help me. They've been really supportive, and they've always been there when I needed something, as far as help with math. I know that with further courses they're going to be harder, and I'm sure I'm going to need a tutor so I know that I'll be set.

The knowledge that support will be there when they need it comforted the student-athletes, and eased some of their apprehensions of pursuing higher-level mathematics classes.

One may question what reason besides needing help in mathematics would a student-athlete interact with a mathematics tutor within the Academic Support Services. Examining an earlier discussion about how some student-athletes found interacting with their mathematics instructors intimidating or unproductive, the mathematics tutor provided a less formal or authoritative representative of the mathematics community for the student-athletes to engage in mathematics. Katie explained her experiences with her instructor, "I saw him [the instructor] probably once every two weeks on problems with homework and stuff …I was getting so frustrated." Katie then looked for others that she could discuss her mathematics with, including her boyfriend. However, she still found issues working with her boyfriend since, "…we're so close to each other, you know how that goes you just want to fight when he's trying to help me." Thus, Katie would turn to the Academic Support Services to, "…call my tutor up and be like, 'Hey, can we meet an extra hour this week?' She was pretty lenient on it, so she helped me a lot." Meeting with a mathematics tutor provided student-athletes an additional outlet to engage in mathematics, and in a setting which they found more comfortable. These additional sessions also served to provide student-athletes with an increase in exposure to mathematics. Jenna explained her interaction with her mathematics tutor, "I have tutor for math right now, but I always get my homework done before I see him, so we never really have anything to do." However, instead of doing nothing, the tutor encouraged Jenna to, "…go over the same stuff that we already finished. He [her tutor] will put problems up on the board, and he'll tell me to solve it. Or he'll teach me shortcuts, which is nice because my teacher always tells me the long way." Thus, the Academic Support Services offering mathematics tutoring to their student-athletes allowed for student-athletes to find assistance when they were struggling, discuss mathematics with individuals it a less stressful setting, and become exposed to concepts they may not see in their mathematics classes.

While most student-athletes found working with tutors to be a positive experience, this was not the case for all student-athletes. Shelley recounted an experience with a tutor:

> I had this one tutor who was horrible. I knew more than she did, and that's not saying a lot either. I would be like, 'Why do I even come if she doesn't even know what we're learning, and I have to correct her every single time?' I would be like, 'You're wrong.' Then she goes and reads the book and goes, 'Okay, you're right. Never mind what I just wrote down on the board.' She has the board full of equations, and I was like, 'Oh my god.'

Shelley described this experience as a contributing factor to her negative perception of the Academic Support Services. Allyson's experience with her tutor at the Academic Support Services was similar to that of Shelley; Allyson explained, "I've gotten one tutor, and that was just a disaster because I felt like I knew more than he did, so that was not good." For Allyson, this caused her to seek out support from her fellow mathematics classmates. Shelley's experiences resulted in her pursuing mathematical assistance elsewhere on campus. Since Shelley already was intimidated by her instructor and her tutor from Academic Support Services was unable to help her, she turned to a mathematics support services operated by the university mathematics department on campus. This service was available to all students, and was located within the same building as the mathematics department. The staff consisted of graduate students and mathematics faculty. Shelley described her experience at the mathematics support service:

> There was this one lady that I would go into the math support here that we have; you can basically go in at any time and get questions answered. I would go to her every time I had written homework due, so she could help me…Every time that I would go see her, she would help me with her fullest. She was the only reason that I would stay in the class, because she helped me out so much.

***Teammates*.** Student-athletes arrived at the university as individuals from a variety of backgrounds, but once on campus they joined their teammates to form a team. The team environment offered a natural community building environment since the athletic competition gives the student-athletes a common goal to work toward. Luke, the deputy director of the athletics department, described how this effects the student-athletes' interactions with other students, "You tend to socialize and hangout with the people that you are with all the time." He found from the annual survey the athletic department administered to the student-athletes that student-athletes often cited a lack of time for not being involved with other groups or clubs on campus. However, Luke explained, that there were still a large numbers of student-athletes that were active in clubs, Greek organizations, and campus government. The involvement of student-athletes on campus may go unnoticed, Luke admitted:

> …if I had to stereotype it, I would have to say that student-athletes tend to hang out with other student-athletes." He rationalized this stereotype, "[If] I spend 30-40 hours a week with guys on the football field, that's probably who I'm going to be hanging out with off the football field.

Shelley discussed her relationships with "Non-Athlete Regular People (NARPS)" by explaining, "I hang out with other athletes, like some volleyball players and stuff, a few track athletes, but I don't know, I wouldn't say that I really find something in common with NARPs." Because of this she explained that she often spent her time studying with her fellow student-athletes.

The close-knit nature of many of the teams at the university helped student-athletes to receive academic support from their teammates and fellow student-athletes. Katie described the different types out support her teammates provide, "Sometimes if we see each other going to class we're like, 'Hey, good job, keep it up.'" and "If one of us does happen to miss class, and we have another one in the class, we'll help each other out and tell them what they missed and stuff like that." The assistance student-athletes provided one another went beyond that of simple moral encouragement, Katie also described how:

> …if one of the other girls on my team has problems with algebra or geometry then I'm always telling them that, 'I'll help you. I enjoy doing math, just let me know if you need help, and I can help you with it.' Usually they come to me, sometimes I can help them, but sometimes I'm like, 'You might want to go to see

> your teacher on that problem because I don't want to give you the wrong direction on which way to go.' I enjoy doing math a lot.

Katie not only offered to help her teammates with mathematics, but she also received help from her teammates as well. She explained:

> They [her teammates] helped me pass calculus…my teammates, most of them, usually they go to you at the beginning of the year and tell us, 'If you're struggling with a class that we have taken, come see us and we will help you.' We're just looking out for each other, we all want what's best for each other, we all want each other to pass and get good grades. We're willing to do whatever it takes. If we can't help them, then we'll guide them in the direction of somebody who can.

This showed the team's closeness could be transferred from their field of competition to the student-athletes' academic studies, and provided evidence of how teammates may influence how student-athletes engage in mathematics.

While student-athletes' athletic accomplishments can impress and inspire fans to become more engaged in a sport, student-athletes' mathematic success can influence and motivate other student-athletes. Listening to Jenna talk about her teammate's mathematical ability it was clear the impression her teammate had on her:

> [My teammate] happens to be really, really smart at math, like crazy smart. I don't know what class it is in math right now, I think it's statistics…it's somewhere way up there, it's a high level one, her average right now is 102% because she gets all the bonuses and always gets 100s on everything. She always like brags, she's like, 'Hey, look at my grade.' In my problem solving class, she also got 100%. She always gets 100s in her math classes.

Kathleen expressed similar sentiments as she talked about how her teammate Allyson changed her perception of mathematics, "That's kind of changed it [her perception], just seeing how much she likes it [mathematics] and enjoys it, but other than that I haven't really seen many other people like math that much." Both Jenna's and Kathleen's teammates' mathematical success and interests have influenced their perception of what student-athletes can accomplish through mathematics. Kim discussed how her own mathematical experiences and success has influenced how her fellow teammates perceive her:

> I think it's cool when I tell people that I'm a math person and I'm an athlete. People are like automatically, 'Oh my god, you're so smart!' and like 'Oh my god, you're so strong!' I think that's the biggest benefit you get because a lot of people hate math, and I think that's horrible because it's fun. It can be fun, it can be really fun…it can be hard, but I don't know. That's kind of cool, an extra incentive…not that I brag about it, not that I go out and say, 'Guess what? I'm a math major.' When I say that it's awesome because people are like, 'Oh man, that's so cool. How do you do it? Math and sports?' I think that's the fun part about it.

Kim's mathematical identity gave her a sense of uniqueness among her fellow student-athletes, and she took pride in this distinction.

While there was evidence suggesting student-athletes could indirectly influence their teammates' engagement of mathematics through their own accomplishments and pursuits in mathematics, student-athletes' mathematical abilities can also directly influence their teammates. Paul described how his teammates have been a source of a support for him:

> …we've got some great scholarly athletes on our team. They're always saying, 'If you guys need help.' They are the leaders on the team, they're always saying, 'If you guys need help, just let me know. We can come over to my house and we can help you out, no problem.' It's nice to have that. I know not all students on campus have that, have that brother-ship of people who are willing to help anytime. That's really nice to have.

This "brother-ship" Paul talked about between student-athletes may stem from the bonding developed through student-athletes working together toward a common athletic goal. Student-athletes were then taking this bond, and transferring to their academic goals as well. Student-athletes also expressed satisfaction helping their teammates with mathematics as well. This can be seen through Kim's account of her experiences helping her teammates at her last school:

> At my last college, I used to tutor my other teammates all the time because they were in the basic algebra or…some of them were in like calculus and I would help out a little bit, just because it's like…I mean some of the calculus is crazy, you forget a lot of stuff once you stop using it. I thought that was cool.

While Kim was quick to help her teammates at her last school, she found that the resources available for student-athletes through the Academic Support Services at her current university no longer made it necessary for her to help her fellow teammates as much as before. This suggests that even though the Academic Support Services provided assistance to student-athletes, this help may diminish the need for student-athletes to seek support from their teammates.

Student-athletes' ability to help their teammates can be diminished by the content of their mathematics courses. Adam described this difficulty as he talked about getting support from his teammates for his elementary education mathematics class:

> I think it's kind of harder because I'm in a whole different spectrum of math classes in a way. Sometimes, one of my roommates is an engineer, I think he's in Calc III this year or he already took Calc III, so he's really smart, he's up there in math. If I ever have a question about it, he's pretty helpful. Sometimes it's hard though because…it's hard for him to explain it…

The focus of Adam's elementary education class was not just to understand the mathematical content, but also to be able to explain their mathematical reasoning at the level of elementary students. For this reason, Adam explained that he would not ask his teammates for help unless his problem involved working more with a mathematical formula. Adam's roommate's inability to explain his mathematical reasoning proved to be a hindrance while helping his fellow student-athletes with their difficulties in mathematics. Adam described this hindrance:

> …my other roommate is in Calc I. I have two roommates, one is bio-engineering and one is a mechanical engineer. The mechanical engineer is already done with Calc III, and he's only a sophomore…we're all sophomores, but he's way advanced and the other one is just a step or two behind him. Even then he's trying to help him out and it's kind of hard for him. He's like, 'You have to use this formula, and you just do this it's really simple.' It's hard for my other roommate…

While there were some difficulties for student-athletes to help each other with their mathematics, there are other ways for student-athletes' to support their teammates mathematically. Kim explained how she was able to use her mathematical knowledge to help with her teammate's educational experience:

> …right now it's finals time and I've done a spreadsheet of all my classes and what I have to get on my finals, like percentage-wise, to pull a B or an A in the class. She [her teammate] thinks that it is the coolest thing… she wanted me at the beginning of the year to do that for her so that she knew what she had to get on her final. I think that's funny because I've always done that, and she's like, 'Oh my god, this is so new to me.' It's kind of cool, it's kind of cool to help people and get that extra incentive.

In addition to using their mathematical knowledge to help their fellow teammates, student-athletes also used this knowledge to discuss mathematics with each other about mathematics. Allyson described her teammates as being "like my literal family", and that:

> I definitely talk with them [with her teammates] about it [mathematics], just because I see them so much. A lot…I think two or three of them are engineers so we can kind of talk about theorems and concepts and whatever. Other student-athletes…I don't necessarily, unless we have class together.

Allyson's experience suggests that student-athletes in mathematics and education possessed a closer bond to their teammates, than just to student-athletes in general. Furthermore, it seemed that Allyson perceived the student-athletes that were not her teammates almost the same as her classmates. When asked how often student-athletes were classmates in her mathematics courses, she responded:

> …more so at the beginning of school because I was in calc and differential equations, and all the classes that engineers are required to take as well as math majors as well. There aren't a lot of strictly math major athletes, but there are a lot of engineers. So a lot of those classes we would have together and work together, and I actually made some friends with those student-athletes.

Allyson expressed that she was unfortunate in not being able to continue to find student-athletes in her later mathematics courses. This suggests that student-athletes' classmates served as another source of support in their engagement in mathematics.

Peers. The first two outlets for support examined involved resources that only student-athletes could gain access. One support system all students had the potential to tap into was their peers. These peers consisted of classmates and friends of student-athletes whom provided support in their pursuit of mathematics. The spectrum which student-athletes viewed their non-athlete counterparts was quite broad, ranging from student-athletes not being able to relate to their non-athlete peers to student-athletes whom found their classmates to be vital assets to their mathematics education.

As the student-athletes discussed their perception of their classmates, some student-athletes did not differentiate between their classmates who were athletes or non-athletes. Stewart described the relationship he had with his fellow classmates in his elementary education mathematics course:

> …I perceive everyone as really social and get to know everybody, open-minded…We have to get along really well because we have to work together because you have to be able to talk to people. As a teacher, one day you're going to be talking to somebody in a classroom, so we all get along really well.

This gave evidence that the structure of a course may impact how student-athletes interact with other students in their mathematics classes. Adam echoed similar sentiments as he discussed his own experiences from his elementary education mathematics class:

> I don't see anybody different or anything in that aspect. I don't think there's any difference held between people and student-athletes. I think I might have mentioned being a student-athlete maybe once or twice in my class, but it's never been brought up, we've never talked about it at all.

As Adam continued to discuss his classmates, one issue he brought up was their performance or ability they demonstrated in the classroom, "Sometimes there's kids in my class that I'm like, 'How do you not get this?' It's not because you're a student-athlete, it's just that I feel like some of the stuff [mathematics], at least what we do is kind of simple." Classmates' work ethic and performance were also a concern for Diana; she explained, "…there's the kids who walk in three minutes late to class every day and don't work that hard, and then there is the other kids who really put forth a lot of effort who I go to for help." Katie described these concerns in greater detail:

> I've noticed in my lower division classes, I don't find that half of the class is probably average, and then a lot of people don't even want to be there. They just sit there or don't even show up to class…Test day the class was full, then you would show up for class, and no one would be there because it was such an easy class that no one really wanted to put forth the effort…That happens a lot, so it's my perspective of a lot of students in lower division classes they just don't care, and they don't go to class because they think it's easy and they don't need to.

From all of these accounts, this gave evidence that student-athletes' value of work ethic shaped their perception of their classmates. This gave further support that student-athletes carry their athletic principles to their academic identity, and how student-athletes view their classmates impacted how they interact with their classmates.

Student-athletes are exposed to competitive environments through their athletic activities; they can also encounter a competitive atmosphere within their mathematics courses with their classmates. Kim described how she felt her mathematics classmates perceived her, "…for some reason I've felt this way, that they [her classmates] get it more, that they understand it…it comes naturally to them or they've just had the time to process all the previous classes." She went on to explain her reasoning for her thoughts:

> …I never had that time to study before. For the first three years of college, I just went to class and I hoped I was doing something right. If I looked at the material for 30 minutes a week, I thought I was doing an okay job because I was so tired before and I couldn't do stuff. They either understand it more, or they have ingrained it more into their brains so that everything comes quick to them, and it takes a longer time for me to get it.

Kim's experiences demonstrates where her athletic commitments were taking her away from her academic responsibilities, and she expressed that she felt her fellow classmates could pick up on this, "Sometimes that they're all like, I don't know that they think of me as like, 'Okay, I'm a jock, so I'm not going to put as much effort into it.' I don't think that's the case, but that's how I think they view me." The fact that the one aspect Kim mentioned of how her classmates viewed her was in regards to the effort she put forth in class gives further evidence of how student-athletes view the importance of work ethic. Kim continued to discuss her relationship with her mathematics classmates, and how she sensed that her classmates attempted to compare themselves to each other in class:

> …math students, I don't know if this is with every other student, but they're really eager to see what you got on a test score, and they'll be like, 'Oh yeah, I got an 89 and you got a 79. I'm better than you.' I don't know, I don't know why that is, but every math class I've ever had there's always one person in there that is like, 'What did you get on your grade?'

Thus, Kim is faced with a competitive environment, where her classmates try to determine who is the best based upon their resulting grades. This attitude contrasted the supportive team atmosphere that student-athletes experienced from working toward a common goal with their teammates. Kim explained how she would respond her competitive classmates, “Well, I got an A or I got a B, but I also had to practice for six hours this week. What did you have to do?” Kathleen expressed similar sentiments:

> …sometimes we have a week off of practice after conference. I realize how much time I have to focus on school, so sometimes watching them [her classmates] in class is kind of irritating because I realize how much time they have to get really good grades. It’s kind of like an envy sometimes…

Thus, Kim’s and Kathleen’s responses suggest that student-athletes can be on the defensive when interacting with their classmates due to the competitive nature of their classes. When I asked Kim if she ever found herself comparing herself to her classmates, she explained:

> …I try not to do that because I know it sucks when I’m like, ‘Oh yeah, you have a D, well I got a C…ha ha.’…Normally I’m on the bottom end of the scale, but that doesn’t mean that I don’t understand stuff, but I just don’t have enough time to process it sometimes or what not. Especially during season, the season is kind of crazy.

The hectic nature of student-athletes’ athletic schedules impacted how their peers are able to support them in their mathematics education. Kathleen explained, “It’s kind of hard because any time we try to do study groups, my schedule is always like, ‘We can study at 10 o’clock at night.’ So, no, not really. I tried, but it just doesn’t really line up.” Allyson expressed similar obstacles in being able to work with her fellow mathematics classmates, “…most everyone who wants to work in a group wants to meet up during the day, like before 5. I don’t get done with my days until after 5, that’s when I can start doing homework and stuff. That can be kind of hard.” Allyson explained how this effected whom she worked with on her homework, “Usually I’ll do it alone, just because of my schedule.” However, when Allyson needed assistance or wanted to discuss the mathematical concepts from class she mentioned, “…we [her and her classmates] will all kind of talk through things if we don’t get them. I have a couple sets of kids that I’ve had a couple years now that we'll call each other, and try to figure it out together, or we will meet up." Being able to meet with her classmates proved to be an asset in her mathematics education; she explained:

> …we do bounce ideas off of each other. I think that does help a lot, because you're working late and you're working on this project or this problem, and you just can't quite get it, and you need a little push of encouragement. My classmates have definitely been a huge help.

Thus, student-athletes' athletic commitments can cause conflict in how their classmates are able to support their mathematics education.

Sport. In order to preserve the confidentiality of the student-athletes, the student-athletes were disassociated from their respective sports, and were referred to as only belonging to either an individual or team sport. Since this section involves the explicit discussion of the student-athletes' respective sports, identifiers were removed from student-athletes' quotes.

One aspect of student-athletes' culture not considered as a possible influence on student-athletes' cultural relationship with mathematics was their respective sports. However, after a brief reflection, the sport that student-athletes participated seemed a logical factor in how they perceived mathematics, due to the significant amount of applications of physics present in each sport. Student-athletes' extensive knowledge of training and techniques associated with their sport may have provided them with an awareness of the presence of the inherent applied mathematics within the physics of their sport that members of the mathematics community do not possess.

Some of the mathematics student-athletes engaged in during their training is quite elementary. One student-athlete discussed during a lifting practice that:

> In the weight room, when we need to put our weights on the bar. Me and my workout partner, we're always like, 'How much weight do we need to put on to make it this certain amount of weight?' The bar is 45[lbs.], then you need to add each specific [weight].

The mathematics the student-athlete described was as simple as figuring out how much weight was needed to be added to a 45-lb. bar and how to convert weight between kilograms and pounds, so these activities required the student-athlete to engage in mathematics at a level no higher than that of a basic mathematics course. Another student-athlete explained another simple application of mathematics:

> …running is a really good example of that because you're always trying to figure your splits for different things and how to get the best possible final time by keeping fairly even times in short intervals…also, just figuring out mileage and pacing…

While the student-athlete acknowledged that all the mathematics used in calculating time splits over distances and tracking mileage as "pretty basic math", the student-athlete pointed out, "but it's math." These examples of mathematical applications were fairly straightforward.

However, as stated earlier, the student-athletes possessed a level of knowledge of their sport beyond that of a casual observer, and this allowed them to tap in much more specific applications of mathematics within their respective sports. Mathematics naturally arose as one student-athlete discussed the act of throwing a shot put, "I constantly throw them up super flat. They'd go far, but they would go super flat, so if I would get a better angle on it they would probably go further." This became even clearer as the student-athlete recounted the advice given by one coach, "You need to release the shot put at a 33 degree angle. If you release it there, it's going to be golden." Another of the student-athlete's coaches related the student-athlete's physical constraints to the physics of shot putting:

> …if you have a bigger shot put you can apply more force on it and more torque so it can go further. I have baby hands for the shot put world, so I was thinking about getting a smaller shot put, and he said that would probably be a bad idea because I wouldn't be able to flick it as much, because I was a rotational shot putter.

Thus, there was evidence of a much deeper understanding of physics and mathematics present within student-athletes' understanding of their sport.

One student-athlete described her exploration into the physics and mathematics behind swimming by doing an experiment on how:

> …angles relate to swimming, and arm pulls because if you have a wrong angle on your arm pull you're going to get a shoulder injury. That's if you have too narrow [of an angle], if you have a wider angle between your arm and your shoulder, if it's too wide then it's not going to be as effective as if it's a 90° moving into…no, it's a 90° angle moving out of it.

Being ignorant of the physics behind the freestyle stroke in swimming, I questioned her further about her experiment. She explained:

> In high school, I sprained my ankle in PE, and we had to do a project on something athletic related and so I was like, 'You know what, I'm going to do it on angles and swimming.' It actually turned out pretty cool because you can also find out the average distance between your legs that causes a more effective kick, and the angle between your legs bending to get the best effective kick. All I did was pretty much watch videos of Olympic swimmers and compare them to videos of us and take measurements of what they were doing compared to what we were doing. Then take an average swimmer, like a national level swimmer, and then do that one to, and I compared them all together and did all the different angles to see which angles were the most effective. Obviously the Olympic people had the most effective angle.

After comparing video between different levels of swimmers, the student-athlete investigated further by taking flat object and pulling through water to determine, "…the force it brought back, how much water was collected, based on the different angles, and that proved to be close to what the Olympic swimmers were doing. It was pretty cool."

Thus, this gave evidence that student-athletes awareness of mathematics within their sport can stimulate their interest in mathematics. Furthermore, the student-athlete was able to use the knowledge gained from the experiment to become a more efficient swimmer:

> …we were watching this video where we were learning technique on arms, and I was like, 'Okay, her arms 45°, okay 90°, okay now it's like…it's a little bit over 90°, then she finishes up.'…it makes sense to me, because when I'm swimming I can be like, 'Okay, my arm is at a 90° angle, I'm doing the right technique.' It helps, it helps a lot actually.

While some student-athletes used their knowledge of mathematics to improve their performance or understanding of their sport, student-athletes also used their knowledge of their sport to better understand mathematics. One student-athlete connected one soccer practice to the concept of Euler circuits:

> …Euler circuits and Euler paths they kind of remind me of soccer…You know when you figure out when you go here, then you can't go here, and then you can't go back there. It's just like…it's kind of how soccer is, we play games like that all the time. We played it yesterday; you have the grid setup in nine different quadrants and you have to…if you get the ball in one grid you can pass it to the next grid, but you can't go back to that grid. I think that with my brain being trained like that, I like, it's easy for me to understand those kinds of things.

The student-athlete went on to discuss how these mathematical ideas were present within an attacking strategy, "It's also like when you're in a game. You get a pass from somewhere over here, and always the object of the game is to get it to the other side where there is not as many opposing defenders. It's easier to get a goal or attack." This provided evidence that by connecting mathematical concepts to student-athletes' sports may improve their mathematics education.

Multiple student-athletes discussed how their sport influenced their perception or engagement of mathematics. There were times which the student-athletes described techniques or actions in their sport, but at times student-athletes appeared to acknowledge the physics of their sport separate from mathematics. A diver explained, “I’m not in a math oriented sport, but diving involves a lot of physics. Have you heard the expression, ‘Longer lever, greater torque?’ Coach uses that probably every single day of practice. It relates how you get into dives to flip faster…” Another diver described diving as not involving mathematical equation, but “…if I have this much power and it needs to go up and not out. If I go this far out, then I can’t go that high.” Both divers demonstrate an understanding of the physics present within the sport of diving, but neither discussed the underlying mathematics used to describe the torque or power used in the different physical motions of diving. However, mathematics was brought up in a conversation about the momentum divers have in relation to their angle of entry into the pool, “…a lot of the entries is based on your angles. If you’re a little bit short of 90 you’ll have a clean entry. If you’re on 90 you’re going to go over a little, and if you’re over you’re going to go over.”

Related Coursework. While there was literature that supported the rationale for hypothesizing that student-athletes would receive support in their engagement of mathematics from the Academic Support Services, their teammates, and peers, it was not expected that student-athletes’ awareness of the connections mathematics played within other subjects would support their perception and engagement of mathematics. Katie described how mathematics presented itself within her wildlife management courses to analyze species populations:

> We’ll do logistic graph and exponential graph, and how carrying capacity goes into all of that. A lot of it, especially in ecology, we have to understand on a graphical scale what is happening. If this is the rate and this is the population versus the number over population, how the line is going to change on the graph.

Due to these mathematical applications in her course, Katie rationalized that:

> You have to really have a good background in math to be able to understand that. I know people who are not very good at math, and they struggle with that in class because they don't understand the graphs. Therefore, they're not going to understand what's going on with the population…

Katie's understanding of the importance of mathematics and its relationship to her coursework seemed to suggest that this awareness deepened her appreciation with mathematics; she explained:

> The harder the math, the less I like it, but the more interesting that it gets. I like it in the sense of what it brings…like the population equation and stuff like that. You can really find the population is based on the simple…equation. Especially the population growth equation for bacteria. That is amazing that you can actually find out the population of bacteria just based on three, I think it's four…no three variables, its three variables. It's just awesome, but then I always thought, I'm always going to love my basic math because it's what's easy to me, but you have to eventually do something harder because it gets more interesting.

This suggested that Katie's motivation to pursue higher-level mathematics is related to her understanding of its applications in areas of her interest. This connected to Dr. Sheehan's, the chair of the mathematics department and a former student-athlete, comments that athletes understand that hard work can pay off, it doesn't always, but it can pay off. Dr. Sheehan described that at some point students goes from just having to pass mathematics classes to becoming engaged in the mathematics. When this happens, Dr. Sheehan explained that, "Suddenly they start seeing applications, how to use the big concepts." Because of this he encouraged his mathematics students to enroll in physics or engineering courses to reinforce concepts and develop their appreciation for mathematics.

Katie recognized that her mathematical knowledge allowed her to better understand her wildlife management courses. She recounted an instance where she was able to apply her mathematical knowledge in class:

> There's actually my professor for game and fish principles, I've actually corrected him on some of the equations because I'm like, 'Well if you've taken calculus before, that's not the right equation that you would use for this situation.' One of the equations is $\frac{n^{t+1}}{n}$, but…we had a chart and it said 1998, 1997, 1996, and 1995, and he wanted us to skip from 98 to 95, and I was like, 'That wouldn't be $t+1$ if that's the chart that is given, but if you were only given 98 and 95, then 98 would be the $t+1$ and the 95 would be the t.' He hadn't, so I did it with the 95 and 96, and took the average, and then I went 96 and 97, and took the average. So I had to have him correct the equation so more people would understand it, because if you were given a chart with those it's not just n^{t+1} it's n^{x}, whatever the given one is over n.

Thus, Katie's willingness to share her mathematical knowledge with her class and professor, she was able to support the learning of all of her classmates. This support, of course, is not possible without a professor who is open to students' feedback, and willing to make adjustments in-class. Katie's understanding of the content within her wildlife management courses seem to be deeper due to the mathematic knowledge she developed in her calculus class.

Student-athletes' understanding of the applications of mathematics within their coursework provided an opportunity to develop a greater appreciation of mathematics which may result in a more positive perception of mathematics. There was also evidence of student-athletes being able to connect mathematics to their courses which seemed to have little to no mathematical applications. Kim described how her Spanish class influenced her perception of mathematics:

> I haven't taken it [Spanish] in a long time, it was blowing my mind. I couldn't connect anything, plus my vocabulary from like three years ago had pretty much disappeared…learning a new language is very mathematical because you have to have different components to plug it in.
>
> She attempted to express her thoughts through an example:
>
> You have to have the structure of a sentence in Spanish; it's different than our English language, so we were talking about the negations of different recommendations in Spanish. That's very mathematical because it's all up in the

> air, you don't know if it's true, you don't know if it's going to exist. It's an if-then statement.

Kim then explained relating her Spanish class to mathematics has benefitted her, "…once I connected that to math my Spanish class has been easy, it's been cake. I can get it. I understand it. I have a pretty good grade in it. It's just comes much easier." Kim's use of mathematics to support her learning in areas that may appear void of mathematics, proved to be an unexpected system of support. She was the only student-athlete that mentioned applying mathematics in this way. This may be attributed to Kim being the only student-athlete interviewed who was pursuing a degree in pure mathematics.

Influence of Authority Figures

When the student-athletes described their perception of mathematics or their choice of a major, often they mentioned an individual or individuals who influenced them. These individuals generally possessed a level of authority over the student-athletes, whether their authority was parental or instructive in nature. The following examination explores how student-athletes' authority figures shaped their relationship with the mathematics culture within the university.

***Coaches*.** Much of student-athletes' athletic responsibilities are dictated by their coaches. Furthermore, student-athletes' coaches have a significant influence over their athletic identities since their coaches determine how student-athletes engage in their respective sports. Coaches' position of authority in student-athletes' lives led to the exploration of this relationship to see if coaches' authority extended into student-athletes' perception and engagement of mathematics. Student-athletes possessed a unique relationship with their coaches, a relationship that does not exist for non-athletes at the university.

While student-athletes' coaches tracked and disciplined student-athletes for poor academic performance, the coaches seemed to have little influence on student-athletes' mathematics education. Paul described his coaches' influence on his mathematics education, "It's sad to say, but most of the time the coaches aren't really focused on…they want you to get good grades. They say, 'Go get good grades.' But they're not going to say, 'Hey come to my house and we'll do this problem here.'" Allyson's experience with her coaches involvement in her mathematics education paralleled Paul's as she summarized discussions with her own coach, "He asks about classes, but he never really asks questions more than like, 'How's the homework load?' I wouldn't say that my coach has ever really had any influence." Thus, it seemed that at the university level, student-athletes' coaches did not influence their education in any specific field. Even though coaches provided only a broad academic support to their student-athletes, this encouragement impacted on student-athletes' outlook on their overall education, which in turn impacted their mathematics education as well. Shelley imparted her coaches' philosophy, "…when one area in your life is good, then everything else comes so easy and everything else is good." She then described how this philosophy surfaced in her own life:

> If one area of my life is sucking, even if it's my personal life is down, then everything else is down. Then if I'm doing really bad athletically, then everything else is shit. The same with schooling, if I know I didn't do good on the test, then I'm out there sometimes, I think about it and I'm like, 'Crap.'

Thus, Shelley's coaches helped her recognize that each area of her life as a student-athlete mattered, from both her academic and athletic sides. Moreover, in contradiction to Abe's perspective of coaches' academic values, Shelley explained, "They [her coaches] value my academics almost a little bit more than I do. It's really bad for me to say that." She expressed what this meant to her, "It's really cool to know that people care about you that much, and care about your schooling that much that they are doing so much in their life to make you successful in all areas of your life…" The student-athletes' responses suggested that coaches at the university did not have a direct influence in their engagement or perception of mathematics. The academic support coaches provided was often generalized, this may have been due to teams consisting of student-athletes with varying educational goals and coaches wanting to be able to support the student-athletes as a whole team.

Collegiate coaches did not appear to have a direct influence in student-athletes' academic identity, and in particular with their mathematics education. However, student-athletes did mention their high school coaches when talking about how coaches influenced their mathematics education. Stewart spoke about two of his coaches, "I did have two coaches in high school that were math teachers. They're actually really good at it." He went on to describe his experience having his coaches as his mathematics teachers:

> Yeah, I took Algebra II. They taught all of them pretty much. They were pretty much my math teachers going all the way through high school, which was kind of nice being that they were the coach and they were somebody that you could relate to as well.

This suggested that Stewart's coaches' dual role of coach and teacher was beneficial to him since they were able to build a relationship through both school and athletics. Kim explained that she had a similar connection with her high school coaches as well:

> They [her coaches] were two math teachers that I really liked…I was constantly around them, and I became their little pet because I was good at it [her sport], and

> I cared about it. Most kids in high school care about their sports, but they're not obsessed about it. I was obsessed.

She detailed the experience with her coach that pushed her towards mathematics:

> One coach, he was an elementary, not an elementary, a special education math teacher, he told me, 'You should really go into teaching.' That's why I initially, at my last university, went into math education after I changed my degree. I thought, 'Yeah, I could definitely see myself teaching somebody, coaching, and being involved in it later down the road.' Those guys for sure. I had other math teachers that were great, but my coaches were definitely cool about it.

Thus, there is evidence that coaches can have a significant influence on student-athletes' mathematics education, but the coaches that are doing the influencing are student-athletes' high school coaches and not their collegiate coaches. Generally high school coaches are teachers either at the school or within the school district. Therefore, high school coaches have an opportunity to be more actively involved in education side of student-athletes' lives than collegiate coaches since they share similar dual athletic and academic identities with their student-athletes. It could be argued that this gives the high school coaches are more vested interest in their student-athletes' lives beyond that of athletics. Furthermore, the subject that high school coaches teach may influence the field of study their student-athletes pursue.

Parents. While coaches' position of authority applies only to student-athletes, parents can serve as authority figures for both athletes and non-athletes alike. However, unlike coaches, parents possess a level of authority over multiple aspects of student-athletes' lives. This different position of authority gave parents their own distinct opportunities to influence student-athletes perception of mathematics. Student-athletes mentioned their parents as more of an avenue of a general support for their overall education. This did not mean that student-athletes' parents had zero influence on their perception and engagement of mathematics.

Allyson explained how she felt her parents perceived her decision to pursue a career in secondary education, "I think my parents were definitely glad I was going to what I chose because my brother is in mechanical engineering, so they were kind of expecting something similar out of me." She added that even though she was not an engineering major, from her parents' view, "At least I'm doing math as a focus toward education." This suggests that student-athletes' parents' perception of mathematics can have an influence over student-athletes' perception of mathematics since the importance Allyson's parents' mathematical values appeared to have transferred onto her. Katie's dad had a similar influence over her perception of mathematics as well. Katie described her dad's experiences with mathematics, "…he didn't take any math in college, I mean that's the only thing that prevented him from graduating from college was math, he just never did it." Katie's father's mathematical shortcomings did not prevent him from sharing mathematical experiences with her. She gave an account of one of these shared experiences:

> …we did a whole remodel on a house…He would come to me and be like, 'Okay, I have this board, and I have this so what do I need to do and show me math-wise.' So I would have to sit there and like, 'You need this length of board and that…' He's really good at that kind of math, but as soon as it comes to algebra, he can't do it. The geometry and stuff that has to do with construction, he's really good at, and so he'll have me do it and then check to make sure I did it right. We just kind of checked each other's' work, which was nice.

From Katie's account, it appeared that her dad was aware of his own deficiencies in mathematics, and did not want to pass them on to her. Thus, it seemed Katie's dad attempted to instill his mathematical values by having Katie use mathematics as they worked together. This may explain the reasoning behind the satisfaction Katie described she drew upon from understanding the presence of mathematics throughout her life. Kathleen also described her shared experiences with her dad as a contributing factor to her perception of mathematics. Kathleen explained that her father sparked her curiosity in mathematics, "My dad is really, my dad is an accountant and he does all that financial stuff. He would show it to me, so it always kind of interested me. I found out more that I liked it when I got into college and I got into some more difficult things." Furthermore, Kathleen's dad pushed her to complete her own taxes, with some coaching from him, and this she described taught her, "…how it's important to be independent so that I understand it myself."

In addition to demonstrating the relevance and presence of mathematics outside of the classroom to student-athletes, parents can also be an influence on how student-athletes engage with mathematics inside the classroom. Katie explained how her father involved himself in her classroom mathematics, "He struggled a lot, so he always helped me with my math homework so he could kind of pick up on how we do it now in days." Again, this gave evidence of how Katie's joint experiences with her dad working with mathematics helped shape her current positive perception of mathematics. However, some of Katie's dad's perceived struggles with mathematics, in particular with mathematics teachers, also seemed to surface in Katie's engagement of mathematics. She described her dad's experiences, "…he never really learned it too much because when he went to school if you didn't do it the way the professor did it, it was wrong. He didn't like that; he would do it another way…" While there are some similarities in Katie's and her dad's frustration with their mathematics instructors, Katie did not let this become an impediment in her completion of the required mathematics courses for her major. Other student-athletes discussed parallels between their mathematical experiences and their parents' experiences. Paul's description of working with his mom on his mathematics homework revealed her perception of mathematics, "…in high school I always…I'd ask my mom, 'Hey do you know anything about this math assignment I got going?' She would say, 'That looks like a foreign language to me.' That's probably where I get my math skills from, my mom." This suggested that Paul contributed some of his mathematical difficulties to a genetic inheritance from his mother. Paul was able to find mathematical support at home from his step-dad. He went on to describe the help he received, "My step-dad, he's great with math. He's like, 'Let me see that. This is easy, Paul. We can do this in no time.' He's like, 'Let's just sit down and I'll teach you the basics that you need to know and you can figure it out from there.'" Paul continued this behavior of seeking out mathematical support from individuals that he "respected" while at the university, as he mentioned often going to see his mathematics instructor when he needed help.

Parents' personalities can also contribute to how student-athletes engage in mathematics as well. Kim described how her dad influenced how she perceives and works with mathematics:

> My dad is a super anal person, and so in math you have to be super anal, and I think that's like something that he taught me. With math homework a lot of people can skip steps, and I think that's sloppy. It's cool that you can skip steps, but I definitely like to show my progression. I like that OCD path.

This suggested that she found the need to layout her thought process in clear steps as a possible hint of obsessive-compulsive disorder (OCD) in how she engaged in mathematics. Kim detailed how this shaped her perception of mathematics, "That's what

I think is fun, making everything perfect in math…I don't know, it looks pretty on the page once you get all your homework done." Kim also explained how her thoroughness can be useful when trying to help others with mathematics, "…I definitely like to show everything so it helps the next person if I'm helping somebody out. I'm like, 'Oh yeah, I went through this step and this step.'"

Teachers. While coaches and parents possessed some influence over student-athletes' engagement of mathematics, often these authority figures' encouragement and educational support focused on student-athletes' overall education success instead of specifically emphasizing any one subject area. This is where student-athletes' mathematics teachers possess a unique opportunity to influence student-athletes' engagement and interaction with mathematics since they are the main authority in mathematics for student-athletes.

Paul described his own experiences with his mathematics professor:

> …my math professor here at the university, he's probably been the best professor I've ever had in my time being here. Any degree area, he's been the best professor I've had. He was willing to teach you anything, at any time, at any place. If he saw you anywhere, he would stop and ask, 'Hey, you doing alright? You getting this stuff? You getting the material alright? If you need any help, come by my office, it's always open.'

Other student-athletes shared a perception of their mathematics teachers similar to Paul's. Most student-athletes explained that they saw their mathematics as being some of the most supportive faculty on the campus. Adam mentioned the relationship he had with faculty at the university:

> I think that's what I liked about some of the math teachers that I had as of late, they're people that you can talk to, they're not just people who are going to stand up write formulas on the board for 50 minutes and then leave. I could have conversations with him outside of class and after class.

The student-athletes considered how being a student-athlete affected their relationship with their professors. Stewart described:

> I’ve heard that there are some teachers that are real tough down the line, and there are other teachers even for the same class that are more laid back so…most of the time they’ve said you’re going to get somebody who will work with you, especially being a student-athlete, they understand what you’re going through and they don’t just assume that you’re the jock. They assume that you’re playing a sport and you’re also trying to get a degree. Overall, I think the faculty is willing to work with all students, all students, athletes, no matter who you may be.

Thus, the relationships formed with mathematics faculty described by the student-athletes suggested that the relationships aided in student-athletes’ engagement with mathematics, and made their mathematical experiences more encouraging and enjoyable, even for some of those with low amounts of mathematical experience.

While Stewart was a freshman with just over one semester’s experience with the faculty at the university he was aware that instructors may have differing perceptions of student-athletes. Adam explained how he felt his professors perceived him:

> I think by being a student-athlete we are kind of held to a higher standard in a way…I think some instructors can be more lenient with you because they know the fact that you are a student-athlete, and they kind of work with you. But I kind of feel like there’s some teachers that, ‘Oh, I have an athlete in my class, you’re going to miss a lot of tests,’ they’ll be up front with you and not be very friendly or cooperative, so that can make things tough.

Allyson described her own perceptions of how her position as a student-athlete influenced her relationship with her teachers:

> I wouldn’t say I’ve gotten negative feedback necessarily, some of them haven’t been too excited about it, but they’ve never been negative or anything. So that’s good. They’ve generally been really understanding that I’m on a team and we travel sometimes.

Allyson detailed the accommodations she received as a student-athlete from her teachers:

> I guess the only real accommodations that I've had are if I missed a test; making it up the next week or when I got back. That's the only hard thing, and that doesn't happen very often, which is a blessing. Other than that, it's usually if you are gone on the day of homework, give it to a friend to turn in or give it to me before you leave, so that can be kind of stressful since the homework is due two days early. That's okay, it hasn't been bad. They've been really helpful; all my professors have, as far as missing classes.

Kathleen gave an account of her own experiences, "Some of them [faculty] were super supportive of me being a student-athlete and others weren't at all." She went into further detail:

> …it kind of just depends on the professor. Some of them are really cool with everything as long as you stay awake in class and turn everything in, and then it's fine. A lot of it is I think is first impressions and how you act in class. If you kind of walk around like some other athletes, like you think you're the best, then obviously you're not going to have a great relationship with them. Just communicate with them, they respect you for that.

When asked what she noticed separated the two differing perceptions, she explained:

> There wasn't any particular subject that was one way or the other, but some of them just weren't willing to help me remake exams and stuff. I had meets, so I had things that I had to miss, and they weren't really open to helping me out or catch me up. A lot of them, especially math professors, were kind of intimidating to go in and talk to.

She gave reasons for why she felt this way, "I think they're more problem focused. I would go in and they would ask, 'What problem do you have?' I didn't have a single problem, I had [a problem with] the whole concept. A lot of them didn't speak English very well, so that didn't help." As she tried to tell her professors that she didn't understand the concept, she found that, "…a lot of times they just get more frustrated, or they would do what I said earlier where they would literally take my pen and [writing on paper motion] 'Now do you get it?' No, but I got the answer though, so thanks." This suggested that Kathleen's struggles to work one-on-one with her mathematics professors negatively influenced her relationship with the local mathematics culture. These negative experiences her professor may have also hurt her engagement and performance in the class as well. Kathleen explained that she would receive some help from asking questions during her classes, but often she admitted that she was too shy and quiet to ask questions in class, and that deserved some blame for not asking more questions in class.

Kim gave a contrasting account of her experiences with her mathematics professor at her previous university, “I had an amazing teacher at my last university…you could tell that he was in education prior and mathematics at the same time because he knew how to relate really hard information to us.” She described a specific class she had with this teacher:

> In Abstract Algebra, the first time you take that class your mind gets blown because you didn’t know any of this stuff existed, and so he knew how to relate the information to us because…he had education experience, he knew how to relate stuff.

Kim explained her teacher made this into one of her most enjoyable classes:

> …because he was such a good teacher, and he knew how to ask you questions. You wouldn’t just go into his office hours, and he would write out the thing and give it to you. He would work you through the process of thinking through the stuff which was awesome.

This suggested that how mathematics teachers support their students’ might influence how they build their understanding and perceive the course. Kim’s perception of her mathematics professors at her current university also supports this idea. She described her thoughts of the mathematics faculty at the university:

> As far as this university, I haven’t really gotten to know a lot of the professors on a one-on-one basis, but they’re really smart, they’re crazy smart. You can kind of tell when you have a closet nerd as a teacher because they have so much information to give to you, and they almost word vomit on to you.

Kim explained how this made her feel about the faculty:

> That's reassuring because you know they [mathematics faculty] have gone through the process of learning all this information, and they're excited about it too, so it kind of excites you. You're happy to go to class because it's something new that you learn, and they're really excited about it too, so it kind of makes the whole class exciting.

This provided evidence that a mathematics teacher's perception and interest in the class can be transferred to the students in the class, and therefore influenced their engagement in mathematics.

Allyson's mathematics professors influenced her understanding and perception of mathematics by relating the content to real world applications. She described her experiences with her professors:

> I think one thing I really lucked out with professors, especially last semester…we were talking about really interesting stuff, they put it in really real life terms, and teach us how to go about it. An example is like the last class that I took was Applied Algebra. We were talking about how they do coding systems for credit cards and how to find out if that's a legit code based on certain things. It's really cool ideas even if the concepts are hard to master. So that's been cool, because a lot of my professors have at least been able to make it interesting, even if it is hard work. That's been cool.

Allyson added, "Teachers have definitely triggered my interests, especially as I get higher up into my classes that I'm taking; making me more curious about how all it works and the history behind it." This suggests that student-athletes' interest in mathematics can result in student-athletes persisting in mathematics. Allyson gave further details for the reasons behind her relationship with her mathematics professors. She explained:

> I guess a good example, a professor I'm taking right now. I had him for Linear Algebra and I had him again for my History of Math class now. He just was really laid back, and gets you to understand…I don't know, he was really good at explaining without shoving down your throat or feeling that it was way over your head, even though it was way over your head. That was kind of cool.

She explained his teaching style further:

> I just liked the style that he went about it, it was mostly a discussion, where he was discussing with the class exactly what he was going through, as opposed to simply lecturing at us. That was nice. He didn't, you knew that he knew his stuff because he would rarely look at his notes, and when he did it was just to make sure that his calculations are right for problems that we were doing in class.

Thus, her professor's content knowledge and attitude were contributing factors to Allyson's positive perception and experiences with mathematics. She explained how her relationship with her professor made her feel comfortable about her athletic commitments as a student-athlete:

> I think it's always good when you feel comfortable around a professor, that you could go up and ask them, 'Hey, I'm missing the next four Fridays,' which I've had to do." I don't know; there's definitely a couple professors that I've had that I would try to avoid ever taking again, but those are not as many.

These types of interactions with professors were unique to student-athletes, and student-athletes' university-endorsed athletic commitments placed student-athletes in these awkward situations with their professors.

Allyson described characteristics of professors that she would try avoid in future education:

> Kind of like what I was saying about my high school math teacher, my calculus teacher, he was a really good mathematician, but not a good teacher. I had one of those last semester, and it wasn't just me, because I thought, 'Well, maybe it's just me, maybe I'm just not picking up on how he is teaching things', but everyone else in my class was struggling with the same material I was.

This experience with one professor shaped how Allyson engaged in her subsequent mathematics class. Unfortunately for Allyson, she had multiple instances where her experience with a mathematics teacher negatively affected her in other mathematics classes. Allyson described how her high school mathematics teacher impacted her first mathematics course at the university:

> I took it [Calculus I] in high school, but I retook it because my high school teacher was…interesting. He's a really smart guy, a really awesome mathematician, but just not the best teacher, so it was a bit of a struggle. So I started with Calc I my freshmen year.

While at the university, Allyson thought her experience with one mathematics professor caused her to be unprepared for her following coursework. She explained:

> Then we got into our…like these were all math ed majors, so we got into our classes this semester, and our teacher was like, 'You should have learned this,' and we were all like, 'Whaaaat? We did not learn that.' I think that is part of the risk of these higher division math classes, how teachers can teach it however they want, since there isn't necessarily any book or anything. You just kind have to go with the flow.

While many student-athletes cited their collegiate mathematics teachers as influencing their relationship with mathematics, some brought up their high school teachers as positive influences. Jenna described her relationship with her high school mathematics teacher, "My high school math teacher, my homeroom teacher, influenced me. Also, going back to grade 9, when I was the smartest in my class, she was really pushing me to do good. It was the relationship that we had that really made me so into math." She went on to explain how this relationship developed:

> …we were together for three years. I knew that she was a math teacher, and I would always come to her for help if I didn't understand anything. She would just help me with my math…We developed a close relationship, where we would talk about our personal lives, like friends and family problems. That's what made me like wanting to know more about math, because she was there and I felt comfortable around her.

The relationship Jenna's mathematics teacher built with Jenna allowed her to push Jenna in mathematics. Jenna described this push:

> I don't know what it was, but she was just so good at teaching things. I didn't understand why other people wouldn't get it, but I would. That's kind what was the push, just me doing good. I feel like it's probably because everyone just fooled around, because that's when everyone is changing and flirting or whatever

> with other people. I would actually pay attention. I wouldn't ever get behind. I think that's what made me do good.

This followed the idea earlier described that student-athletes' success in mathematics can influence their relationship with mathematics, and Jenna's account of her experience with her high school mathematics showed that it is possible for a teacher's relationship with student-athletes to influence their mathematical achievement.

Allyson described her experiences with her high school mathematics teacher, "She [Allyson's mathematics teacher] kind of made me see how…I guess how beautiful math can be, and how it all works out… because she was such a good teacher, she was my inspiration I guess you could say." Allyson's account of how her mathematics teacher revealed the beauty of mathematics provided evidence of how Allyson's mathematics teacher helped to begin shaping her perception of mathematics. This same mathematics teacher inspired Allyson to want to teach the specific content of trigonometry and pre-Calculus within the secondary mathematics curriculum. Allyson compared her high school and collegiate mathematics professors:

> As far as other math teachers…in college I haven't really had any of them try to associate what I enjoy, maybe it is the best way of putting it. They're also kind of trying to just get you to learn the subject, and they know that all of the people in their classes already like math, so it's not like they have to force it on you to like it.

While Allyson's idea that all students in mathematics classes like the content of the course is idealistic, she did bring up the idea that high school teachers teach under different circumstances than college professors and instructors. This difference may contribute to the type of relationship that develops between student-athletes and their teachers.

Most student-athletes talked about their actual relationships with the mathematics faculty at the university, but only one consider how her relationship might change if she was not an athlete. Allyson described her interactions with her professors outside of class:

> Almost unfortunately. I mean, I've gone into their offices when I need help, but once I'm out of their class I rarely see them, with the exception of a couple professors who I'd take again because I like them so much. It is kind of hard to I guess, because I know a lot of my other classmates have SI (Supplemental Instruction) periods, and they're helping out with a lot of math professors in the department as part of their, I wouldn't say their work experience, but kind of like work experience. I really don't have time for that with my schedule.

The Supplemental Instruction that Allyson referred to was a program funded through a teaching center on campus, and hired undergraduate students to provide additional assistance outside the classroom for courses that typically have low passing rates, such as College Algebra and Biology. Allyson's comments suggest she would have attempted to further her relationship with the mathematics culture at the university if her athletic schedule would allow her. She considered how her engagement of mathematics would have changed without athletics by describing her peers work with the local mathematics community:

> They [her peers] will help out with one class three days a week, or something like that. They're still getting to know the professors, and getting the gist on all the teaching aspects behind the classes, but they're not fully responsible for teaching the kids. I think that is something that I would be interested in, but I just haven't had time in my schedule.

Thus, it appeared that Allyson would have become more involved in the local mathematics culture if she had the available time in her schedule.

When student-athletes cited time constraints as a reason for not being able to engage into a group or activity which they are interested in on campus, Abe explained:

> I think that it is an excuse. We plan their days out very, very efficiently…You can see that their days are pretty well planned out. If you look, most fraternities or

> sorority functions are going to be here, or if they want to do something like student government it's going to be during the day. They have that time. I think it's just a very convenient, ‘I'm tired.’ In-season, I can see where it can be a problem because you're going to see game here, game here, so you might only have two days free.

He admitted though that:

> …when I was at another university, we had kids that were in honors programs, in sororities, in fraternities, but it's a special kid that can do that. Because when the other kids are playing Play Station or napping or out with their girlfriend or boyfriend, they're not doing that. They're doing that function that they want to be part of. It just, it's kind of like having a family and then going out and hanging out with your friends. You're making decisions constantly and you have to be accountable for those decisions. I think that it can be done, but it takes a unique person to be able to do both.

Influence of Career Goals

The previous sections examined student-athletes’ mathematics education experiences, authority figures, and support systems, each of which required student-athletes to reflect on their prior experiences to determine how these experiences shaped their current perception and engagement of mathematics. When student-athletes discussed their career goals, defined as their desired career upon graduation, they had to now consider their future goals, both short and long term goals, since they were working toward an aspiration.

Student-athletes recognizing the relevance or applications of mathematics within their desired career goals served as an influencing factor on their engagement with the local mathematics culture. Adam described, “In a way kind of because being a teacher I need to know how to do that [mathematics]…the stuff I’m doing I have to retain it, and I actually am going to have to learn this.” This suggested that Adam consciously decided to approach his mathematics classes in such a way that he would be able to apply his knowledge in his future career as a teacher. Furthermore, his awareness of his role as a mathematics teacher informed how he engaged in the content of his mathematics classes. Adam explained:

> You're learning, you have to sit here and try to decode what this student did…you have to learn this is his thought process, and you have to learn how are you going to make this easier for someone to understand. Rather than I know how to do this my way; I have to learn how to do it all the different ways and learn how to teach them to make it more apparent to the kid.

Adam compared his mindset to that of students not pursuing a career in education, "Instead of just, 'I'm good at the quadratic formula so that's all I'm going to do. That's all I need to do. I just need to know my way to figure it out and I can get through this class.' I need to figure out all these ways because I am going to have to use it." He also expressed a desire to use his mathematical knowledge in his teaching to keep students engaged in their learning.

Allyson expressed similar sentiment as Adam as she discussed her own future as a mathematics teacher, "I want to be the teacher that gets you to enjoy it [mathematics] even if it's not your favorite subject." Allyson's recognition of the importance of mathematics in her career and awareness of possible challenges that lay in front of her helped shape how she engaged in mathematics at the university. She described an obstacle that she would encounter in her teaching, "I guess I kind of view it [teaching mathematics] as a challenge because so many kids…it's everyone's least favorite subject in high school, and that's what I want to teach." Allyson explained how her own experiences as a student contributed to her view of why overcoming mathematics' negative connotation is important, "…knowing that so many kids are just going to hate it. It could be really beneficial. You could turn their minds around on it, because someone turned my mind around on it." While these ideas and experiences informed Allyson's decision to pursue a career in secondary mathematics education, it was the coursework involved in her major that have developed her appreciation for mathematics; she explained:

> …initially I kind of thought coming into college that it would be a little bit of an easier road because I was going into the education aspect of it [mathematics], and not just a strict mathematics degree. I kind of realized that that's a lie…because all I've taken are upper division math classes.

She expressed an appreciation for these advanced mathematics classes and how the content connected to her career:

> …it has been cool because it has gotten me to really enjoy the upper division classes more because I am really interested in and how all the concepts I learned in high school I guess, just coming from a teaching perspective, do apply to all the classes I'm taking now.

Much like Adam, Allyson's educational career focus required her to examine mathematics from additional perspectives. She described this as a challenge due to the fact that she was not only learning new mathematical concepts, but she must also think about how she would teach the material to her own students.

Not all student-athletes were pursuing careers that explicitly involved mathematics such as teaching mathematics. This did not prevent student-athletes from recognizing the uses of mathematics within their career interests. Katie explained how she would apply her mathematical knowledge within her career in wildlife management:

> I'll go out and calculate populations and then determine how long the hunting season needs to be, when the hunting season needs to start, how many opening days do we want, and it depends on how many…trophy animals there are versus how many just regular animals there are.

She seemed to understand how mathematics was involved in her calculations of species populations given particular constraints. Katie went on to describe the importance of her population calculations in wildlife management, "If there are too many animals then there is not enough food for them and they'll just starve to death, and we would rather them die quickly than die painfully." While Katie was able to recognize specific applications of mathematics within her career, other student-athletes could only speculate where they might use mathematics in their careers. Paul reasoned that he would use his mathematics experience to be able to read graphs and give him the confidence that he would be able to solve any problems he encountered in his game guiding service. Kathleen also discussed using only basic mathematics in her career as a missionary, such as fundraising and managing expenses.

Allyson's educational career path required her to enroll in some advanced mathematics courses. While she had not initially planned on pursuing mathematics to such an extent when she entered college, these advanced mathematics courses sparked her interests. In fact the mathematics she was exposed to in these courses motivated her to pursue even more mathematics courses. She described, "I technically could fill up my schedule, the empty slots I have, with those easier intro level classes about things that I may be interested in, but it's just busy work and it's not something that I really [find interesting]" Allyson explained that she was looking to take courses that she had interests in, but at the same time were relevant to her future career:

> I took psychology, which was kind of interesting, but I also couldn't find anywhere that I could apply that into my own life teaching…I just feel like I do love math classes, and taking classes that could actually be beneficial for me later on would obviously be kind of nice, as opposed to feeling that, 'Oh, this is just a class that I have to get done.' I want to be interested in it.

Allyson continued to express her interest in mathematics, and then reflected on the possibility of pursuing a second degree in pure mathematics:

> I thought about that. I actually talked to my adviser about that last semester because I am on a five-year route. I have a couple open slots in my schedule that

> need to be filled. I asked her what it would require for me to get a math degree from arts and sciences, as well as an education degree. Pretty much she kind of, I don't want to say shot me down, but told me that it wasn't as important as I would think because it is a concurrent major for the state. You get a math degree as well as an education degree, but it's all out of the department of education.

This suggested that while Allyson's career in education pushed her into some mathematics class, from her adviser's recommendation it appeared that as a career in secondary mathematics education she only valued a mathematics background up to a certain point. Allyson was not fully deterred by her adviser, as she explained that she had talked with her classmates about still pursuing a second degree in mathematics. She found out that she would need another three to four classes to be qualified as a pure mathematics major.

Allyson's career goal to become a secondary mathematics teacher did not appear to place a high value on a pure mathematics degree. Knowing this, Allyson rationalized that a mathematics degree may still be a worthy investment of her time. She explained, "…because if I decided teaching wasn't for me or I wanted to try something else first, having a legit math degree would be sweet." Allyson reasoned:

> I think that because it [a pure mathematics degree] wouldn't be associated with the education aspect, some people that saw it on a resume might take it more seriously. Like, 'Oh, she's a math major.' As opposed to, 'Oh, through education she got a math degree.'…I guess that's more from a hiring perspective than anything else.

Allyson suggested that an employer's perceived difference between a secondary mathematics education degree and a pure mathematics degree could be a deciding factor in hiring her, and that a pure mathematics degree may open more job opportunities outside of the field of education. Kim appeared to recognize the impact her mathematics degree would have on her potential future careers. She explained how her career goals had influenced her perception and interest in mathematics:

> Especially, if I go onto school in architecture. I was looking at…some of the requirements for some of the schools and math is a big one. Obviously, if you're trying to build a building you need to be able to put some figures and numbers together, and that's always been fun.

Kim described connections between mathematics and architecture:

> …it's always been in all my drafting classes in high school and stuff like that. With mathematics you have to be crazy precise, and I think that's the thing that I like to carry on. You have to be accurate about this or stuff is going to fall apart…or you're not going to get the right answer, you're going to be off.

She discussed the importance of accuracy and precision in mathematics and architecture, and finished her thoughts by saying:

> I like to be precise about everything. I like to be sure about everything I do, except for right now when I don't know what I want to do as a whole career….I think that math has definitely taught me that [the importance of precision and accuracy], and that will carry on my life forever.

Thus, Kim's awareness of the connection between mathematics and her career goals had an influence not just with her perception of mathematics, but on her overall life outlook.

While there were student-athletes who had an understanding of the career opportunities a mathematics degree provided or how mathematics related to their future career, this was not true for all student-athletes. Jenna asked the question, "Well with being a math major you could be…what could you be, a math teacher?" She went on to reveal, "I don't know where math can take you." Because of this she explained that she never considered pursuing a degree in mathematics since she did not know what she could do with a mathematics degree. This may not seem like a significant finding, but examining Jenna's secondary mathematics education experience this becomes a more noteworthy result. Jenna recounted her high school mathematics experiences:

> We had this thing called homeroom, where you would meet with them every single day at the beginning of the day. My homeroom ended up being my math teacher. I really like math so much that I wanted to get ahead, so in grade 10, because high school only starts at grade 10. So in grade 10, I had math with her. I took a math class on-line. Then I took two grade 10 math [courses]. In grade 11 I was with, not her, but this Asian lady. It was kind of hard to understand her because she had a really heavy accent. She made it fun. I really liked it so much that I did math in summer school. I finished my grade 12 math in summer school, so my whole grade 12 year I didn't have any math classes.

Jenna was so engaged in mathematics that she was taking her mathematics courses early in high school. When she finished her mathematics classes she confessed that she even missed mathematics. Thus, there was evidence of a student-athlete, who had actively pursued mathematics in secondary school that saw no future career in mathematics, and thus only became minimally engaged in mathematics at the university level.

A lack of understanding of the career opportunities associated with a mathematics degree may account for the small number of student-athlete mathematics majors. Allyson remarked, "…a lot of people when they think more of a math oriented degree they think engineering, like automatically people are like, 'I'm going to be an engineer. I'm going to make a ton of money.'" Allyson explained that she perceived that mathematicians and engineers engage in a lot of the same concepts, just with a different emphasis. Because of this she reasoned, "I know a lot of kids…who are going into engineering and stuff who could do super well in the math department just because they know the topic and they're interested in it, but they just take it into a different direction…" Allyson suggested putting forth the question to these student-athletes, "Yeah, science and engineering is really important and that is a cool job to go into, but what about math?" in an attempt to broaden their perspectives about what is involved with mathematics, and that mathematics is "…more than just what you learned in high school." Luke addressed this concern briefly. He explained that the athletic department brings in speakers and counselors to discuss with student-athletes about their majors and what they can do with their majors. Even with these resources there still appeared to exist a lack of understanding of career opportunities in mathematics. Some of this may be attributed to speakers and counselors are reaching out to student-athletes after they already settled on a choice of major, or that the speakers and counselors themselves were not fully aware of the opportunities that exist with a mathematics degree.

Mathematics Culture

While there are postulates, axioms, and theorems that are rooted in the foundations of mathematics that are used to define the global mathematics culture, for one to define a culture, one must also develop an understanding of its members' perceptions and experiences. Since each college and university has a unique collection of individuals within their mathematics department, each school possesses its own local mathematics culture that is a subset of the overall global mathematics culture. To understand the mathematics culture of this university; to develop a textural description of the local mathematics community's individual and shared experiences, skills, values, forms of expressions, and social institutions that are rooted in mathematics, four members of the local mathematics community were interviewed.

Mathematics Department's Role within the University

Understanding a culture required examining how the culture fits within its habitat or ecosystem. Thus, there was a need to discover how members of the mathematics culture described their role within the university. What became clear was that the mathematics department possessed multiple roles, and depending on an individual's perspective these roles could change. Marie described this differentiation between roles:

> I think that's up for debate. I think sometimes that there's a difference between what the math department thinks and what the overall, the A&S (Arts and Sciences) really, which is our parent college thinks. I think it's hard because it is a question of do we want the students to really understand the mathematics for the mathematics sake or are we preparing them for something else.

Daniel reiterated these dual roles the mathematics department fills, "I think most people outside of the math department sees our role as a service department, providing mathematical education foundation courses for science and for STEM (Science, Technology, Engineering, and Mathematics) classes…" and "…we see equal in our minds within the department is the mission to educate and train mathematics majors, undergraduates and graduates."

Exploring this perceived service role further, Dr. Sims explained that the mathematics faculty served a role teaching specific mathematics courses:

> Here we have a lot of students take mathematics classes because they have to meet those [general education] requirements. That is currently being discussed, but up through now students outside of STEM majors have to take two mathematics classes.

Thus, many students interact with the mathematics culture through these required mathematics courses, and these interactions served as their primary source for developing their perceptions of the mathematics culture. Hence, there was also a need to consider how students perceive the role of these mathematics courses to properly examine the local mathematics culture. Marie described how she felt students perceive their mathematics courses:

> It really depends on the student. I've had some students that will say, 'I want to understand this. I can do it, but I really don't understand it.' I think that's great that there are some self-motivated students who are like that. I think a lot of them…I think a lot of undergrads are just checking off boxes to get to the next thing. I think in tutoring down in the Math Lab, the engineers tend to have a little different view since they will be using this pretty much continually for all of their engineering classes. Math majors, they are a little bit different also because they are studying the math to study the math. They probably have a different mindset, but most of the students in College Algebra won't go on to take another math class. If they do, it will be business calc. They're taking College Algebra as a pre-req for things like statistics and things like that. I definitely think most of the students in College Algebra are taking it for a requirement because they have to, because they have to get their university credit or because it's a pre-req for another class that's required for their discipline.

This gave an inclination that these differing perceptions may impact how students engage in their mathematics courses. It was clear from Marie's and Dr. Sim's accounts that a variety of majors and numerous students utilized mathematics courses as preparation for their majors, and thus it was possible to gather insight into the important role the mathematics department played within the university. Even with this crucial service role, the mathematics department endured budget cuts like many of the other departments within the university. Marie explained one consequence of these budget cuts:

> It's been weird the last couple of years because we've had budget cuts. When I first started teaching College Algebra my sections were 35 students, which was a lot more manageable for walking around and talking to each student and having them actually work on something and make it meaningful in the fact that I can go around and look at what they're all doing. Now, its 92 [students]. Budget cuts have been interesting.

These results created a different learning environment for students. This change altered how students interacted with the mathematics faculty, and thus affected students' relationships with the local mathematics culture.

While the mathematics department served a diverse set of students with varying majors, it also maintained its role educating fledging mathematicians and future mathematics teachers through undergraduate and graduate programs. Dr. Sims explained that:

> …the [mathematics] department identifies strongly with…we have students in our major coming from a variety of different directions. One being that we have our education students, they are concurrent majors [education and mathematics], so I think the department appreciates that we have some majors that are going to be future teachers, and strives to help them and support them and fit their needs. I think we also recognize that we have majors that are coming here that are going to go on to graduate study in mathematics, so there are attempts to prepare them and support them with what they need. Then we also recognize students that are in mathematics that are going to be employed in industry and stuff, and aren't necessarily going on to graduate study in mathematics or STEM… we meet different people's needs, but at the same time trying to help them all understand the mathematics.

Therefore, this role of educating mathematicians and teachers were obliged to meet a diverse set of educational goals from even the mathematics subset of the student population.

Perception of Mathematics

A concern regarding students' mathematical engagement was a common theme voiced by each of the mathematics faculty interviewed, but as Dr. Sheehan explained, "…before you answer how people can get better in mathematics and how we bring that about, procure that, we have to really understand what mathematics is." Thus, there was a need to examine mathematics faculty's pedagogical philosophy and practices in order to understand how students learn what mathematics is.

Dr. Sims described that one of her goals for her elementary mathematics education classes, "I'm always hoping in my mathematics classes that students are leaving at least with the sense that mathematics is a logical field." As a result of this goal, she explained:

> I worry less about what all have we covered, I hope people leave more so with the idea that mathematics does make sense. If there's something that we didn't cover, or that we covered and they forgot, and they need to teach it, they know…if they're not understanding it, they know that it's possible to go make sense of it.

Thus, Dr. Sims' appeared to place an importance on developing her students understanding of what mathematics is since this knowledge can help them learn, or recall, mathematical concepts when they are no longer students in her class. She gave reasoning of why she viewed this as such a critical goal of her teaching:

> …this might be reflected in the fact that I teach a lot of classes for the elementary education teacher majors…I think we have a subset of students that come in that view mathematics as a collection of rules and procedures, and they've never really had the chance to perceive mathematics as something that makes sense. I'm hoping that they gain that through my classes, that empowers them to continue learning mathematics. Especially as they come across topics that they need to teach, and they realize it's a little fuzzy for them.

After Dr. Sims outlined her goal of developing students' understanding of what mathematics is, she discussed how her pedagogical practices helped her to achieve her goal. She explained:

> I would say a pretty typical format would be a small group activity or set, where students are working on something or investigating some mathematics in small groups, or maybe some individual things. From the small groups we then move into a whole class discussion, where people share what they found. We talk about different approaches, different perspectives.

Dr. Sims stressed that wanted to create a dialogue that moves back and forth between not just her and her students, but between the students themselves. Such discussions were evident in the observation of her classroom. She would often have students talking and working in pairs before having the students discuss their ideas in front of the whole class. Dr. Sims described her practices in further detail:

> I let them [her students] work, and then I say, 'Okay, how did you solve this?' Then maybe I use that to proceed in presenting some information that relates. I might say, 'Okay, we just solved this problem. This is this type of problem it relates to this, it connects to this.' Then I give them a little bit more information. Maybe another example or two will come up, and I'll let students work on that. It might mean that I come to the classroom and say, 'We're going to study this, which we need to know about for this reason. Here's an example, you guys try it.'

Thus, Dr. Sims attempted to help her students develop an understanding of mathematics as a big picture, and the reasoning behind connections of mathematical concepts. She continued to outlined her role as the instructor:

> It's still a situation where there is some of the information is being presented by me, the teacher, but I'm incorporating opportunities for the students to stop and actively engage in trying a problem, thinking about the problem, or providing input. How is that different from a small group discussion or something of that nature? When it's small group discussion, and then we come to a whole class discussion…those whole class discussions, I try to let those be generated by and flow through how the students were thinking about the material.

In addition to the group work incorporated into her classes, she also explained that she sometimes used an "interactive lecture" that she described as:

> …a little bit more directed in the sense that I want to get these pieces of information out, but I want to make sure that I provide stopping points for the students to have a chance…at least I'm assuming and hoping, engage a little more actively with the material than just listening to me about it.

Dr. Sims' philosophy to develop her students' understanding of what mathematics is addressed a concern voiced by Dr. Sheehan that mathematics is misunderstood by teachers at every level, elementary school through college. Dr. Sheehan explained that mathematics is a language, and then described the problems that emerge due to this misunderstanding of mathematics:

> …somehow we've gotten it into our heads collectively; I'm guilty of the same thing, that we teach a lot of garbage. Five, six years…kids take three, four years of high school math…before that they take middle school and grade school math courses…They are learning nothing, or they don't see what they are learning.

Dr. Sheehan again criticized teachers for not giving reasoning for what they are teaching and not presenting students with a more complete picture of mathematics. He connected this back to his perception of mathematics as a language:

> We're teaching them the alphabet, the grammar, the sentence structure, and even with college math we do a little more of that in the first couple years before all of the sudden we tell them, 'Oh, what we were talking about for six years is just a preamble for what's going to come from here on.'

Dr. Sheehan gave an example of how teachers' instructional practices can develop students' misunderstanding of mathematics:

> I'm sure you've been in lectures at this point that you walked away and said to yourself, 'What the heck was the question?' I have been through many of those, whether they are seminars or colloquiums, lectures that my colleagues give, seminars, whatever…at this stage I'm less patient, after 10 or 15 minutes I raise my hand and say, 'What are you trying to do? I don't get it.' I think I'm accomplished enough in my life that if I don't get it, then probably there is a few other people in the audience that don't get it. Unfortunately, our students don't do that.

He explained that, "I encourage them [his students] to do it, whether they're in an undergraduate class or graduate class, but they don't do it." Dr. Sheehan continued to describe how this practice appeared throughout the levels of mathematics education:

> Think of a tenth grader sitting in an algebra class, and a teacher is teaching a quadratic equation and how to solve a quadratic equation, and the student raises his hand or her hand and says, 'Why do I…What are you doing?' The teacher says, 'I'm teaching you how to solve a quadratic equation.' The student says, 'Why? I can plug it into my calculator and get the answer faster.'

Here if the teacher cannot answer the student's question, Dr. Sheehan saw this as a failed lesson. He explained that too often teachers cannot "bring the lesson home" to give motivation for what the students are learning. Thus, teachers' misunderstanding of what mathematics is transferred to their students.

Dr. Sheehan stressed that teachers did not necessarily have to be highly skilled mathematicians to know what mathematics is, or be effective teachers of mathematics. He explained his thoughts through an analogy involving basketball. Dr. Sheehan pointed out that there are many basketball coaches whose skills do not allow them to play or dunk like LeBron James, Kobe Bryant, or Michael Jordan, but they are aware of and can provide their players an idea for the importance of the play of these elite basketball players. Similarly, he expressed that teachers can explain why they want students to learn to solve equations to motivate students and help build their appreciation of mathematics. Dr. Sheehan connected this notion of motivation and appreciation of mathematics to his current athletic endeavors:

> You can still enjoy it, exactly. It’s not about winning at all costs. There are not too many mathematicians who become world famous because they prove something that is huge, but you enjoy it and you keep doing it. I still run for that reason, forty years later. It’s very much of a parallel.

While Dr. Sheehan expressed frustration over teachers’ misunderstanding of mathematics and its impact on students’ understanding of mathematics, there should also be concern for disconnect between instructors’ understanding of mathematics and the curriculum which they teach. Marie discussed her own perception of mathematics

> I think so many times in mathematics that students have this view of mathematics that’s really not dynamic, that it’s this closed thing that’s finished, that’s finalized, and how you work a problem is you work through these steps A, B, C, D, E, and then you get to the answer. That’s not really mathematics at all, mathematics is really dynamic. If you’ve ever worked on ever actual mathematical something you go all over the place, and when you get done you write it up so it looks like it’s A, B, C, D, E, but the actual process is not like that at all. You reach dead ends, and you go backwards and things like that.

Marie voiced frustration with the difficulty she had incorporating her perception of mathematics in the College Algebra curriculum:

> It's really hard I think to show students that in a class that's so quick. I do try to show students that it's OK to make mistakes. I make mistakes in class all the time, and I pretend or tease them that I do it on purpose, but I don't. I make mistakes and I like it when they catch me because it means that they know what's going on. That was a lot of information, but I believe in having open classes where students can ask questions and discuss and showing students that it's OK to make mistakes. Whenever possible, try to have students try to discover the stuff themselves, at least in some small way so that they are engaged and feel some kind of ownership.

Unfortunately, as both Marie and Daniel pointed out, the amount of content within some of the introductory mathematics courses required the course to be paced faster than they would have preferred. To satisfy the curricula demands, Marie contradicted her own idea of mathematics not being a series of steps in her teaching. Instead of communicating her appreciation and understanding of mathematics in her class, Marie reinforced some of the misconceptions about mathematics through her the teaching of her College Algebra explaining to her students in one class that, "Math is just like your morning routine. If you don't do things in the same order, you might forget something." She used this analogy to describe the steps students needed to go through in order to graph a rational function. Daniel also presented some of the content of his College Algebra course as a step-by-step process. Daniel introduced how to solve quadratic equations. He listed steps for how to solve completing the square, beginning with the generic quadratic equation $ax^2 + bx + c = 0$. Daniel then described the steps for solving the quadratic formula as being "a little abstract because of all the letters", then moved onto use the steps he listed for more concrete examples of quadratic equations. This idea of following a series of steps to solve equations continued throughout the semester as Daniel covered solving quadratic-like equations, sketching graphs of polynomials functions, rational functions, and rational inequalities. Students were also exposed to mathematics as being procedural in nature through the on-line homework associated with the College Algebra course. Daniel explained:

> Each assignment is 10 or 12 problems. The software has a tutorial aspect to it, so if they are confused about a problem they can get stepped through…there is step-by-step instruction how to work problems. The software provides immediate feedback, if they are right or wrong on their answer.

Thus, students' homework taught students the importance of following steps in mathematics. College Algebra was not the only course in which students were presented mathematics in procedural form. In Daniel's Calculus I course, he answered a student's question about a related rates problem by listing the explicit steps for solving optimization problems: (1) Identify quantity whose max/min is desired, (2) Write formula involving this quantity, (3) Express quantity as a function of single variable, (4) Determine realistic domain for the function, and finally (5) Find critical points on this domain and test to see if they are max/min. Daniel then proceeded to solve a series of related rate problems on the board in front of the class, labeling each of the steps as he worked through the problems.

Perceptions and Experiences with Student-Athletes

In order to understand the relationship between the student-athletes' and mathematics' cultures at the university, it was necessary to develop a description of the mathematics faculty's perception of student-athletes. Recalling the athletic department staff's and student-athletes' explanation that a faculty member's experience with student-athletes can shape their view of how student-athletes engage in mathematics; thus, there was a need to examine both the mathematics faculty's experiences with and perceptions of student-athletes.

Not all mathematics faculty had much interaction with student-athletes in their classes. Dr. Sims explained how her lack of experience with student-athletes informed her perception of student-athletes, “My perception of them [student-athletes]… I would comment that I don’t necessarily know enough of them to say for sure, but I’ve had some interaction with them. They’ve usually been strong students. I’ve been pleased.” This gave evidence that even with little interaction with student-athletes that Dr. Sims refrained from perceiving student-athletes using either negative or positive stereotypes, and instead choose to give a brief description of her own experiences with student-athletes. This followed the thoughts outlined by the athletic department staff and student-athletes that many of the faculty on campus will use their own experiences to inform their perception of student-athletes as a whole. Dr. Sims went on to elaborate on her view of the student-athletes by describing the attention the athletic department places on keeping track of student-athletes’ performance and progress in a class, she explained:

> I do think here that the athletic department does a nice job of inquiring of how their athletes are doing in your classes. I get the typical emails saying, ‘How is so and so doing?’ They in some ways, what they’re asking about is a little richer than what grade does the student have in your class right now. They ask some nice questions. They’ll still ask if you could give us a grade estimate right now, approximately where is the student. They’ll ask things like how’s the students attendance, what sort of recommendations do you have for the student to do better, how’s the student doing. They move beyond just what’s their grade right now. They ask enough that we’re in compliance, they seem to really care about learning about the students’ study behaviors, are they doing what they should be doing for class, what’s going on, and are they participating in your class. I found things like that to be good.

The type of emails Dr. Sims described provided evidence of the athletic department’s attempt to keep an open line of communication with the faculty on campus.

While Dr. Sims found the emails sent by the athletic department as a sign of their dedication to student-athletes’ academic responsibilities, other members of the mathematics faculty found them to more of “paid lip-service to paying attention to the academics” as described by Daniel. Daniel explained:

> I have three or four football players in my college algebra this semester, and early in the year they [the emails] ask, ‘How are they doing?’ Well, he doesn’t come to class, he’s failing, I’ve never seen that guy. I fill out a form, and to me it’s I fill out a form and away it goes, that’s it.

When I asked if heard anything back from the athletics department regarding email reply, he responded:

> No, it’s not like, ‘Really, he’s not coming to class. Well, we’ll get on that.’ Nothing happens. I tell them how they’re doing, and it’s like that goes into some type of black hole. Most of the time they’re doing bad, and they continue to do bad. They’re not doing their homework. I tell them that they’re not doing this, they’re not doing that, they’re not doing any quizzes, and things don’t change. I don’t know what’s happening on that end. I don’t know if they’re talking to the kids, and the kids just aren’t doing anything.
>
> He went on to speculate what happens with these progress reports:
>
> I don’t think it gets trashed, because I think they have some reporting that they do. They want to make sure that they can show that they checked all of these grades. I don’t believe that it is trashed, but I don’t know…I don’t how much of it gets to the actual student or why it doesn’t make a difference with the student, behavior doesn’t change. It is hard to get people to change.

Daniel was not the only one to question the relevancy of the emailed progress reports to the athletic department. Marie also explained how the athletic department’s apparent disregard for the work she puts into these progress reports which she replied frustrated her:

> We get to fill out the reports at six and 12 weeks on our student-athletes, that basically asks: Where they are? What their current grade is? How much is left in the semester? Then they ask for any comments about attendance or things like that. I always take the time and fill it out, and I have like 12 students…you know eight to 15 student-athletes in a section of College Algebra. I take the time, and I fill it out, and I fill it out. Nothing ever happened. I had a student last year who didn’t have a clicker…a student-athlete who didn’t have a clicker. I put that in there, I said, ‘He doesn’t have a clicker. This is impacting his grade.’ That’s points that he is missing every single day. I said, ‘Here’s where he can get it.

> Here's what he needs to do.' I said this very clear…nothing. The next one, same student, still didn't have it 12 weeks into the semester, and I literally wrote in there, 'I don't think anyone reads these because I said last time exactly what he needed to do to easily get these points.' I never heard anything back from that either. I don't know if they didn't read it or they were just like, 'She's a little upset, maybe we'll just ignore that.'

Daniel's and Marie's experiences communicating with the athletics department contradicted Abe's proposed commitment to act on issues brought forth by members of the faculty. Thus, the perceived lack of action or response to the faculty's concerns listed in the emails by the athletics department contributed to some of the mathematics faculty's negative perceptions of the student-athletes' culture.

While it may seem that the athletic department inaction in student-athletes' mathematics education resulted in more negative than positive feelings from the mathematics faculty, the faculty recognized that in the end that the responsibility for changing behavior lied with the individual student-athlete. Marie expressed:

> I've gotten emails from the athletic department asking, 'Well, why is this person failing? Is there anything they can do?' I always email back saying, 'They can do the exact same thing that any other student can do. If they come in, I'm more than willing to help them. If they missed things that are excused they can certainly make those up, but they have to make the effort.'

Once again, the theme emerged that student-athletes' actions can dictate a faculty member's overall perception of student-athletes.

Daniel described his perception of the student-athlete culture within the university:

> I definitely have a perception that the majority of the athletes in the big sports, like football and basketball…the emphasis is on the athlete, not on the student. That's my impression. I feel like in the smaller sports and a lot of the women's sports that there you really have a true, what I would consider, a true student-athlete, someone that is here to get an education and participate in sports.

Daniel paused to reflect, and then went on to explain:

> I know it's a very difficult thing…my impression is that for any student-athlete it's difficult to balance them both. I know there is a very demanding schedule to be an athlete, and I know it's demanding to be a student. I think the majority of the sports here on campus are reflection of a true ideal combination of that student and athlete. I think the major sports, the big sports, the emphasis, in my perception, the emphasis is on the athletics and not on the student part.

Daniel expanded on his thoughts by specifically discussing football players:

> There's a lot of football players. This is totally just my impression, but I do think there are statistics that back this up…The football players academically aren't doing so well. When you look at the program and they talk about their GPA, it's buoyed by women's sports and minor sports. Again, this is my perception. Minor sports…it may be just the athletes in those minor sports have a better concept of what it means to be a student-athlete, to pay attention to the student part it of it.

Daniel's perception received some validation during an observation of one of his College Algebra classes the following semester. Following one class in the middle of the semester, he explained that he had two groups of students, nine in total, who appeared to have collaborated on a take home quiz; five of which were student-athletes, the other four students where non-athletes who sat next to each other during class. Daniel described how it was a female basketball player who gave her quiz to football players to turn in for her since she was not always in class. The female basketball player disputed the accusation that she had collaborated on her quiz with the football players, but Daniel mentioned that she had allowed others to see her work when she asked them to turn in her work. As a result of the alleged collaboration on a take home quiz, all students, athletes and non-athletes alike, were required to complete alternative quizzes in Daniel's office during his office hours for the remainder of the semester. Thus, as student-athletes and members of the athletic department staff feared, the actions of a few student-athletes can affect all of the student-athletes.

Marie explained that she too developed her perception of student-athletes through her experiences teaching them during her tenure as a graduate teaching assistant. Marie's explained that her perception of student-athletes differed between male and female student-athletes, "This sounds really bad, but I have noticed a difference between my male student-athletes and my female student-athletes." She elaborated:

> My female student-athletes tend to be on top of things. They tend to email me more often with when they're going to be missing so they can get notes. They come into my office more often to get help. I don't see that as often with my…that's just totally qualitative, like looking back over all the semesters.

Her experiences with student-athletes seemed to be similar to Daniel's. Since Daniel's perception appeared to be dependent on the sport the student-athlete participated more than gender, the questioned was posed to Marie if she noticed that student-athletes' respective sports affected her perception of student-athletes. She answered:

> The male football and male basketball players. They are the ones that I've had the most trouble with in terms of they've been failing the class, and it's the athletic department that's emailing me to say, 'What can we do?' It's not the student coming to me and saying, 'What can we do?'

This hinted at Marie's frustration that some student-athletes disregarded their academic responsibility, and instead relied on the athletics department to keep them informed of their academic performance. Furthermore, this followed Abe's perception of faculty's thoughts on the involvement of the athletics department in student-athletes' lives. Abe relayed that, "Some [faculty] love that [the emails], some hate it. Some don't think our kids need to have their hand held, and they should be treated like everyone else…"

In contrast to Marie's negative experiences with student-athletes, she explained that the student-athletes she was teaching at the time in her College Algebra class were:

> …super great. They email me when they're going to be gone, so I can email them and let them know…they come in when they don't understand something and get help. They're really dedicated. They make up their quizzes; we always setup times to make up their quizzes. I think that's great.

She then returned her focus to football and male basketball players:

> I've had football players and basketball players that have done awesome in this class [College Algebra], and I've had football players and basketball players who haven't been doing well and who have come to me so that we can work together to get it up.

Marie went on to give a specific example of a student-athlete that was dedicated to his academics:

> I had a football player last year, who was the sweetest kid ever. He lived in my office to pass the class. He would come in every office hour. We would work through the homework together, we would work extra examples, and he barely squeaked by with a C. We barely got him through it, but he was dedicated, he was willing to do that. I've had other student-athletes who act like they don't, they don't care.

Because of the variation in her experiences with student-athletes, Marie admitted that she had mixed perceptions of student-athletes. While Daniel was unable to recall specific instances dealing with male basketball student-athletes in his classes, he shared his perception of them:

> I can't really [say]…I've had very few basketball players, so I don't know from personal experience about that. I would still say it's my perception that it is a big sport, and they [athletic department staff] are bringing kids from all over the country, and they're bringing them for their athletic ability and not their academic ability.

The "athlete" label, and the physical attributes of some athletes, can make it easier to generalize behaviors. Flint commented on the effect of this labeling as he reflected on his time as a coach at multiple schools:

> Some professors love athletes, they've had nothing but great experiences, the athletes go above and beyond. Then other professors are like, 'Well I have this

> one athlete that got caught cheating, and I hate athletes. They're the closest thing to Satan there is and we don't want them, and I won't make any concessions.'

He described how he thought faculty developed their perception of student-athletes:

> …you have both drastic extremes at every school that I've ever been at. It all comes down from personal experiences. You get a lot of athletes that do put in the extra time, they go the extra mile, they're in professors' offices once a week and the professors love them.

Flint's thoughts are supported by Marie's earlier description of a football player that was "the sweetest kid ever" who regularly attended her office hours for help. While Flint talked positively of student-athletes' academic commitment, he admitted:

> …you have those [student-athletes] that do the opposite, and are just trying to get the easy way out. I think that's where the professors have those [negative] perceptions. The sad part is that they're students at the end of the day, and they're student-athletes. The same applies for general students, but when you have the athletic tag on you that's their perception of athletes, whether it's good or bad. Guess what? I'm sure every professor has had someone get caught cheating, whether it's with plagiarism or whatever. That goes on that one student; when it's an athlete it goes on all athletics.

Because of this, Flint explained that he tried to communicate to his student-athletes the importance of being a good ambassador of athletics in the classroom. If student-athletes are not adhering to appropriate academic behavior, Flint described how he held his players accountable:

> I say [to student-athlete], 'The first thing you're going to do is apologize to that professor. Second thing you're going to do is take responsibility for it. Third thing you're going to do is repair those bridges and go say that I want to make this up and that I screwed up.'

He then tried to stress the value of accountability in student-athletes lives after college, "That's life. If you screw up in the real world, you better go to your boss and apologize and say, 'I take responsibility,' and figure out how you can fix it. That's what we try to do with it." Thus, conflicts between student-athletes and their professors are not all bad for student-athletes. This is evidenced in Daniel's explanation that during an earlier incident involving student-athletes cheating that the athletic department supported him, and that "they [the athletic department staff] were involved and things were said to their athletes, and things changed." Positive experiences such as these contributed to Daniel's feeling that the athletic department has, and is carrying out, a purpose on campus. Abe described that being available to faculty to correct any wrong was a critical aspect of his role as the Associate Athletic Director for Academic Support. He emailed the faculty at the beginning of each term that included his email, cell phone number, and office phone number. The email was meant to let the faculty know that if they had any problem, they could reach him. Even without having too many experiences with student-athletes, Dr. Sims expressed that "…my perception as a faculty member is that they [the athletics department] are not going to let a lot of shenanigans go on."

As Daniel and Marie pointed out earlier, the lack of interaction with the athletics department can contribute to a negative perception of the student-athlete culture within the university. Thus, there were instances in which the athletics department tried to involve the faculty more in the student-athletes' lives. Dr. Sims mentioned that the athletics department attempts to keep faculty informed of the student-athletes' academic performance. She explained the athletics department sent out a newsletter via email detailing that, "…the athletes average grades where higher than our general student population. This is not the case for many institutions." While Daniel thought that the student-athletes in minor sports helped offset football players' GPA, Dr. Sims found this statistic reflected that, "…this institution is strongly focused on their athletes doing well academically, and I also think that they're pretty strong in terms of holding their athletes to high standards, both athletes and coaches." In addition to the newsletter, the athletics department tried to get faculty members involved with student-athletes outside of the classroom. Abe explained that the athletics department reached out to faculty through an Honorary Coaching program. He described the program:

> We bring in an Honorary Coach that is a faculty member. They get to stand on the sideline of a game or sit courtside, meet with the coaches before, or sit in the locker room during a half-time speech. For every one of our programs, we reach out to the faculty to bring them in so they can see more of what we do. That entitles them to a meal at the game, a tour of our building before the game. It's just another way we are trying to build outreach with them.

Flint commented that this program also helps the faculty "…realize that if they did have a bad experience, it was one isolated person, it's not running rampant in all of athletes and all athletes are that way."

CHAPTER V

DISCUSSION

Student-athletes serve as ambassadors of their respective universities through both their academic and athletic accomplishments. It is the student-athletes' athletic endeavors that place them in a unique role within their college communities. This role presented student-athletes with many experiences during their transition to college and overall college tenure that the general student population will rarely encounter. It is student-athletes' distinguishing academic and athletic experiences that has given rise to the current distinct student-athlete culture that exists within colleges and universities nationwide. The late Myles Brand argued that many of the academic faculty in higher education do not fully understand the responsibilities associated with student-athletes' athletic identity (Roach, 2004). Furthermore, Myles Brand suggested that there is a need for members of academia to develop a better understanding of student-athletes by researching student-athletes' education across a broad range of disciplines. This kind of research may also serve to bring focus back to student-athletes' academic identity (Powers, 2008). Coupling this call to action with Herzig's (2005) argument for the importance of mathematics in furthering students' opportunities in higher education, led to a recognition of a lack of research focusing on student-athletes' engagement with mathematics and advancement of student-athletes' mathematics education. Thus, following Schoenfeld's (2000) suggested purpose of research in mathematics education to develop an understanding of mathematical thinking, teaching and learning, and Hamilton's (2004) explanation that much of reform in student-athletes' education must be accomplished at the local level, there was demonstrated a need to develop an understanding of student-athletes' mathematics education.

The goal of this study was to initiate research in student-athletes' mathematics education by developing an understanding of the cultural relationship between student-athletes and mathematics. The following research question for this study provided direction to develop an understanding of the cultural relationship:

Q1 How do perceptions and the relationship between the culture of collegiate student-athletes and the culture of mathematics develop at a Division I university?

Q2 Does student-athletes' identity, authority figures, career goals, support systems, and mathematics education influence their attitude, interest, and/or motivation to participate in or becoming involved with the culture of mathematics?

In effort to address the research question led to a thorough review the related literature, the development of an interpretivism theoretical perspective through a radical constructivist epistemological lens, and resulted in the adoption of a phenomenological research design to examine this cultural experience through the development themes from semi-structured interviews data. The analyses of the data were conducted through a two-phase method involving thematic development through constant comparison and analytic induction. The results of the data analysis provide a composite description of collegiate student-athletes' relationship to the culture of mathematics at a Division I university.

Summary of Study

The phenomenological study described in this dissertation incorporated semi-structured interviews with 10 student-athletes across varying levels of mathematical experience, four members of the mathematics faculty, four members of the athletic department staff, and two members of the Athletic Planning Committee. These interviews offered multiple perspectives of the cultural relationship between student-athletes and mathematics, which allowed for the development of a composite description of the cultural experience. Additionally, the observations of four mathematics courses and student-athletes within the Academic Support Services provided data to construct a structural description of the cultural experience. The setting included the athletics and mathematics departments at a single mid-sized doctoral granting university in the western United States. Data were collected throughout the 2012-2013 academic year.

The conceptual framework for the study followed the interpretivism theoretical perspective outlined by Crotty (1998), as the purpose of the research was to understand the student-athletes' cultural relationship with the mathematics. To understand this culture, Tillman's (2002) definition of culture as "a group's individual and collective ways of thinking, believing, and knowing, which includes their shared experiences, consciousness, skills, values, forms of expression, social institutions, and behaviors" (p. 4) was adopted for this study. A pilot study (outlined in Chapter III) and review of the literature suggested a need to understand a culture before knowing how to motivate it or reshape it, and thus a phenomenological research design (Creswell, 2007; Crotty, 1998; Moustakas, 1994) was employed to develop an understanding of how student-athletes and mathematics faculty perceived and engaged with the other's respective cultures. Much of the literature review focused on understanding student-athletes' role and identity within the collegiate setting, as well as factors suggested to influence students' perception of and engagement with mathematics. These factors were incorporated into the research constructs, student-athletes' identity, educational experience, authority figures, support systems, and career goals, in order to develop an understanding of the relationship between student-athletes and mathematics.

The exploratory nature of the research coupled with the semi-structured interviews informed the data analysis methods. The incorporation of semi-structured interviews allowed for questions specifically regarding the research constructs developed from the review of the literature, pilot study, and discussions with experts. The analysis of the data occurred over two phases. An initial phase involved analyzing student-athlete and mathematic faculty interview through a constant comparison thematic development process. The second phase followed an analytic induction process in which the athletic department staff interview data and classroom observation data were used to review the themes developed from the initial phase in order to verify, contradict, or elaborate on the themes. This two phase analysis process resulted in a composite description of the cultural relationship between student-athletes and mathematics, as well as a description of the influences student-athletes' mathematics education, authority figures, support systems, and career goals have on their perception and engagement with mathematics.

Synthesis of Findings

The results detailed in the previous chapter included a composite description regarding the cultural relationship between student-athletes and mathematics and detailed the influence student-athletes' mathematics education, authority figures, support systems, and career goals have on their perception and engagement with mathematics. The purpose of this section is to synthesize those findings and provide a source of reference for further discussion of the implications and limitations of the findings.

Through this study the researcher examined the cultural relationship between student-athletes and the mathematics community within a Division I university. The investigation involved analyzing student-athletes' perception and engagement with mathematics in order to examine how the relationship developed. From the some of the analysis some may find difficulty differentiating between student-athletes' and non-student-athletes' experiences with the mathematics community; possibly raising concern for the need or relevance for such a study. However, this difficulty in differentiating between student-athletes and their non-athlete counterparts provides value to the research in two ways. It gives support to the fact that student-athletes are students as well as athletes. Thus, bringing student-athletes' academic identity, and more specifically mathematical identity, into focus. Also, the similarities between student-athletes and non-student-athletes allow for some findings of the research to be transferable to the student population as a whole.

On the surface student-athletes share the same experiences in their mathematics education as students who are not on a university athletic team; they enroll in the same courses with the same professors in the same classrooms. Examining student-athletes' perception of mathematics, based upon their mathematical experience, provided evidence that those student-athletes with low to moderate mathematical experience described mathematics as being procedural in nature. As the analysis progressed to students with higher mathematical experience, student-athletes' understanding of mathematics transitioned from following a series of steps, to considering how these steps may aid in solving a problem, to building on mathematical concepts using reason and logic. However, as this was not a longitudinal study it was difficult to determine when in the student-athletes' mathematics education the change in perception occurred, and what caused the change.

Li and Zhao (2013) suggested that students' experiences in the mathematics classroom are where students construct their mathematical understanding, and also are exposed and absorbed into the mathematics culture. The analysis of the influence that student-athletes' mathematics education experiences had on their relationship with mathematics informed how the student-athletes developed their mathematical identity and perception of mathematics. The student-athletes described reasons for avoiding or withdrawing from the local mathematics culture within the university. The reasons included a perception that the student-athletes did not feel they possessed the natural abilities to be successful in mathematics, they felt intimidated by their professors, they did not see how the relevance of mathematics they learned to their lives outside of the classroom, or they lacked an awareness career opportunities involving mathematics. The explanations student-athletes gave for not continuing or enjoying their relationship with the local mathematics culture were not unique to student-athletes, as other groups of students cited similar issues in the literature. Herzig's (2002) found graduate mathematics students who withdrew from a graduate program explained they did not have the natural talents needed to succeed in their program. Researchers (Hu & Kuh, 2003b; Komarraju, et al. 2010; Middleton and Spanias, 1999) suggested negative experiences and relationships with professors could hurt students' engagement and performance in a class. McDermott (2013) and Watson (2008) both argued that students who perceive mathematics as a set of procedures disconnected from any other purpose than school achievement have little incentive to remain engaged in mathematics. The student-athlete who acknowledged she was unaware of career opportunities associated with mathematics, provided evidence of a student who had actively pursued mathematics in secondary school, but saw no future career in mathematics, and therefore only became minimally engaged in mathematics at the university level. Thus, further similarities emerged between student-athletes' and non-athletes' negative experiences with mathematics and how both groups responded to these experiences.

Examining the student-athletes' mathematics education experience further, each student-athlete expressed various stages of struggle in their relationship with mathematics. Student-athletes from low to high mathematics experience described mathematics as challenging, but as the student-athletes' mathematics experience increased so did their appreciation of the challenge. Those student-athletes with moderate to high mathematical experience expressed their appreciation by discussing their awareness of the relevance and applications of mathematics in their studies and in the world around them. Student-athletes possessing high mathematical experience went further, describing the beauty and scope of mathematics. As student-athletes' mathematical experience increased, their perceptions of mathematics began to align closer with the mathematics faculty's perception of mathematics and the perceptions of mathematics in the literature (Herzig, 2002; Mason & Watson, 2008; Watson, 2008). The results provided evidence of differences in student-athletes' perception of mathematics across the different levels of mathematical experience. Student-athletes who persisted in mathematics despite their mathematical struggles cited their interests in mathematics for providing them the motivation necessary to overcome their challenges. These interests came in the form an awareness of mathematical applications in another field of study or the desire to further understand the beauty and scope of mathematics. Interest has been shown to be a significant determining factor in mathematical persistence (Koller, et al., 2001; Schiefele & Csikszentmihalyi, 1995). Furthermore, the student-athletes provided non-remedial examples illustrating the effect students' interests could have on their engagement of mathematics (Stage & Kloosterman, 1995). While interest was a predicting factor for many of the student-athletes who persisted in mathematics, it did not necessarily determine whether a student-athlete would continue in mathematics. One student-athlete explained mathematics was an obstacle for her pursuing her interest in an engineering degree, forcing her to alter her education and career goals. Thus, student-athletes' interest did have limits to the extent they would struggle through mathematics.

While it may be expected to find variation in students' perception of mathematics based upon the amount of experience they have with mathematics, the findings suggested that there may be an unintended source for this variation, namely the mathematics courses student-athletes were taking. The literature (Grootenboer, 2013; Li & Zhao, 2013) indicated that students develop their mathematical identities through the exposure to the mathematics culture from their instructors' pedagogical practices. Interviews with the mathematics faculty suggested they perceived mathematics as being logical and dynamic; in contrast to the student-athletes with low to moderate mathematical experience, who described mathematics as being procedural. Thus, these student-athletes did not develop an understanding of the mathematics that aligned with that of the mathematics faculty. Observations of a senior lecturer's and a graduate teaching assistant's teaching of College Algebra and Calculus I found the mathematics presented to students as being procedural, giving explicit steps to for students to follow in order to solve problems they encounter. Thus, there existed disconnect between these two mathematics teachers' understanding of mathematics and how they portrayed mathematics in their teaching. Hence, the pedagogical practices of these two members of mathematics faculty may be an unintentional source for some of the discrepancies between students' and faculty's perceptions of mathematics. Unfortunately, the classroom observations did not include observing a proof-based mathematics course to examine to see if the disconnect continued through upper level mathematics courses.

Based upon the findings of the study, the student-athletes' classroom experiences may appear similar to the relationship with mathematics as non-athletes. However, there exist underlying issues that non-athletes do not experience. These issues include the mental and physical fatigue student-athletes experience from their athletic commitments and the perceptions of professors and peers have on their relationship with student-athletes. While some students who do not participate in a college sport may also work 20 to 40 hours per week at a paid job to support their college experience, their employment is not mandated by the university. Furthermore, the unlike student-athletes, the university does not require working students to miss class for their jobs.

As a whole, the student-athletes involved in this study detailed an average day, explaining that much of their day was divided between their academic and athletic responsibilities. They explained the physical and mental stress that was generated from going from an early weight lifting session to classes for the day, then back for at least two hours of practice, before finishing the day working on homework in the study hall within the athletic department's Academic Support Services. The hectic schedule and physical demands challenged the ability for student-athletes to their academic goals, as they attempted to find a balance with their athletic and academic responsibilities. The similarities between the student-athletes' description of their identity and the student-athlete culture detailed in the literature (Gerdy, 2006; Papanikolaou, et al., 2003; Simons, et al., 2007) suggest the findings may be transferable to student-athletes at other Division I colleges and universities.

In addition to student-athletes' account of their daily experiences, details emerged from the findings regarding how student-athletes' perception and understanding of their identity could be shaped by the perception of those around them. In particular, student-athletes felt their professors and fellow students perceived them negatively, which prompted the student-athletes to be proactive in their attempts to dispel negative stereotypes through their behavior inside and outside of the classroom. A senior lecturer and graduate teaching assistant described their mixed perceptions of student-athletes and their attempt to view them the same as non-athletes, but at times their experiences with student-athletes led them to perceive student-athletes differently. Their perceptions of student-athletes as a whole were generally more negative than their perceptions of individual student-athletes. Research suggested that student-athletes awareness of perceived negative stereotypes might affect their academic performance and affect students' engagement with mathematics faculty (Beilock & McConnell, 2004; Hu & Kuh, 2003b; Humphrey, Yow, and Bowden, 2000; Komarraju, et al., 2010).

Research (Grootenboer, 2013; Herzig, 2002; Li & Zhao, 2013; Pfister, 2004) have detailed the significant contributions teachers have in shaping students' mathematical identities. This importance was evident in the findings as student-athletes described their mathematics professors as the primary source of influence on their relationship with mathematics. The student-athletes with high mathematical experience expressed how their secondary mathematics teachers and professors conveyed the scope and beauty of mathematics to them, which resulted in them both furthering their mathematics education. A majority of the student-athletes, across all levels of mathematical experience, also explained how their experiences with mathematics professors impacted how they engaged in subsequent mathematics classes. The student-athletes' described having both positive and negative experiences with their mathematics professors. The positive experiences included professors communicating mathematics in such a way to trigger some student-athletes' interest that influenced their decision to persist in their mathematics education. However, the negative experiences involved student-athletes feeling intimidated by their professors that resulted in the student-athletes looking to others besides their professor for support, such as their peers, tutors, or other student-athletes, in attempt to limit their interactions with their professors. Even with these negative experiences, the student-athletes almost unanimously perceived the local mathematics community as being overall supportive to student-athletes. While the literature (Whitner & Myers, 1986) documented instances in which faculty would provide preferential to student-athletes, the results of this study showed only that faculty provided additional assistance by accommodating for student-athletes' athletic commitments, being flexible with the scheduling of assignments and exam, and by giving mathematical support through an on campus mathematics tutoring center that was accessible to all students. Despite the support mathematics faculty could provide to the student-athletes, student-athletes athletic commitments prevented them from engaging with their professors as much as they would have preferred. This was unfortunate, since research has shown students' development of informal relationships with professors outside of the classroom increased students' self-confidence, enjoyment of college, and academic motivation (Komarraju, et al., 2010; Pike, et al., 2003). Furthermore, Herzig (2002) argued the importance of giving students the opportunity to participate and integrate into the mathematics community increased their persistence in mathematics.

Student-athletes' non-athlete peers provided student-athletes with an additional outlet to engage in mathematics. Classmates also provide student-athletes with other opportunities to participate and integrate into the mathematics culture through their collaborative work outside of the classroom (Herzig, 2002). Student-athletes' non-athlete peers were increasingly important for student-athletes persisting in mathematics since there were not many student-athletes in upper level mathematics courses. Thus, their peers became one of the limited sources of support for student-athletes as they advanced in their mathematics education. Unfortunately, a majority of the student-athletes were not able to take advantage of the support from their non-athlete peers for multiple reasons. One explanation given by multiple student-athletes involved their inability to relate to their classmates because of perceived differences between of themselves and non-athletes peers, such as student-athletes' perception that their classmates viewed student-athletes negatively within an academic setting. The differences resulted in student-athletes developing negative connotations associated with their peers. Therefore, student-athletes with high mathematical experience found it a necessary to learn to work with their peers to be successful in their advanced mathematics courses. Pascarella (2006) suggested the experience of learning to work with different groups of individuals can improve the intellectual impacts of college. Thus, student-athletes collaboration with their non-athlete peers may help improve develop their mathematical understanding. Despite the possible benefits of working with peers, student-athletes still expressed difficulty working with their mathematics classmates due to scheduling conflicts with their athletic commitments and physical fatigue. Thus, there was evidence that professors' and students' perceptions of student-athletes' give possible reasons for student-athletes' separation from the local mathematics culture. The literature (Adler & Adler, 1985; Bell, 2009; Gerdy, 2006; Simons, et al., 2002) indicated that the separation student-athletes' experienced from their peers and professors contribute to the development of a distinct student-athlete culture.

The separation from the mathematics culture experienced by student-athletes provide evidence for the importance of reaching out or recruiting student-athletes into the mathematics culture to help improve student-athletes' mathematics education because often student-athletes cited their teammates as their primary source of mathematical support outside of the classroom. Student-athletes explained they would often work with their teammates due to their close-knit relationship developed through their common experiences and convenience of constantly being around one another. The support student-athletes provided each other developed their academic identity by working together to set academic expectations for their respective teams. Student-athletes with moderate to high mathematical experience also influenced their teammates' perception of and success in mathematics by discussing their own mathematical understanding with teammates or assisting their teammates who were struggling in mathematics. The positive influence teammates had on their fellow student-athletes' academic success contradicts some of the concerns expressed in the literature (Gerdy, 2006; Papanikolaou, et al., 2003; Simons, et al., 2007). Also, in contrast to Gerdy's (2006) and Tull's (2009) research, the support teammates provided aided their development of student-athletes' academic identity.

Aspects of student-athletes' athletic identity also were shown to influence their perception and engagement with mathematics. Faculty may not always consider how influences outside of the classroom shape student-athletes' mathematical understanding. Student-athletes have additional sources of influences from an athletic department funded Academic Support Services and coaches. The Academic Support Services offered student-athletes individualized mathematical tutoring from other undergraduate students. However, not all of the student-athletes needed or took advantage of this tutoring service. Those who did have experience with the mathematics tutoring through the Academic Support Services gave mixed testimonials regarding the benefit gained from the tutoring, ranging from complaining about having to teach their tutors the content they were learning in class to finding their tutors so useful that they would request additional meetings with their tutors. Unfortunately, the Academic Support Services was generally only able to offer mathematics tutors for introductory to intermediate mathematics courses due to being unable to find tutors for more advanced classes. Tutoring was not the only support the Academic Support Services gave to student-athletes; members of the Academic Support Services also provided educational assistance in the form academic advising and served as a buffer between student-athletes' athletic and academic responsibilities.

Research (Bell, 2009) suggested coaches to be one of the most influential individuals in shaping student-athletes' academic identity. The influence stems from the authority coaches possess over student-athletes. The findings of this study aligned closer to the work of Papanikolaou, et al. (2003), suggesting that coaches did not use their position of authority to impact student-athletes' academic identity and were somewhat detached from student-athletes' academic lives. Some of this detachment was by design. The Academic Support Services tracked student-athletes' academic performance and informed the coaches when their student-athletes were not performing or fulfilling their academic responsibilities. The coaches would then administer disciplinary measures in attempts to get their student-athletes to address their academic needs. Not all of the coaches' actions were reactionary. Coaches were proactive in organizing team meetings early in the academic year to help their teams develop academic expectations, such as attending class and sitting near the front of the class. Most student-athletes explained that their coaches expressed a greater desire for them to graduate than for them to perform well athletically. Thus, the athletic department staff appeared to follow Horton's (2009) recommendation of coaches working together with athletic department staff to aid in student-athletes reaching their academic goals. However, most of the coaches described only offered general academic encouragement to their student-athletes, and left the student-athletes to self-monitor each other to ensure that they were meeting the team's academic expectations. While the university level coaches seemed to lack influence in student-athletes' mathematics education, two student-athletes directly credited their high school coaches for influencing their interest in mathematics. One distinct difference to note between collegiate and high school coaches is that at the high school level, coaches are often teachers as well.

Kuh (1990) argued that before one could influence a culture, one must first understand the culture. This study provides evidence of a distinct student-athlete culture within the university, and also gives a description of the local student-athlete and mathematics cultures. Thus, examining a common value shared across both cultures provides a shared foundation to build connections between the two cultures. One value voiced by individuals from both cultures involved work ethic. Student-athletes continually described the satisfaction they received from working hard toward a goal, and then seeing the results of their efforts. The mathematics faculty explained the need of a strong work ethic to be successful in mathematics because of the difficulty of the concepts. To build from this foundation it is necessary to look at other cultural connections that can be fostered to develop stronger relationships. Student-athletes displayed an awareness and knowledge of the inherent applied mathematics within the physics of the training and techniques involved in their sports that members of the mathematics community may not necessarily possess. Student-athletes described the mathematical applications within the sports of running, shot put, swimming, and diving. Research (Koller, et al., 2001; Schiefele & Csikszentmihalyi, 1995) suggested that students' interests were significant contributing factors in engaging them mathematically. Thus, student-athletes' awareness of mathematics prevalent within their respective sports provides the mathematics community a unique source for attempting to transfer student-athletes' interest in their sport to their interest in mathematics.

The findings provide details regarding issues that have been obstacles in the development of cultural relationships in the past. Understanding the past helps to inform the future of the relationship. Thus, raising the awareness of problems in developing relationships between both cultures can help the cultures address existing troubles and avoid potential pitfalls. Making individuals from each culture available to the other culture outside of the classroom also provides the opportunity to develop a shared understanding of the two cultures.

Implications

The purpose of this study was to develop an understanding of the cultural relationship between student-athletes and mathematics. Building on the review of the literature and a pilot study, the research planned to (1) answer the late Myles Brand's call to action by addressing the deficiency in research involving student-athletes' mathematics education, (2) add to the research regarding how different cultures engage and perceive mathematics, and (3) develop an understanding of the student-athlete culture so that mathematics educators, athletic department staff, and student-athletes can influence the culture to improve student-athletes' mathematics education. While the research design, setting, participants, and data may limit the scope of the findings, the study makes significant contributions to the goals of the research. In the following subsections the findings are discussed in relation to implications for educational research and practices to improve student-athletes mathematics education.

Extending the Research

This study adds to the existing literature on how different cultures perceive and engage in mathematics, extending Tillman's (2002) definition of culture to apply to student-athletes, as well as a mathematics community within a university. Additionally, the phenomenological design of the study establishes research focusing on student-athletes' mathematics education through the development of a composite description of student-athletes' experience engaging with the mathematics culture and how student-athletes perceived these experiences. The findings from the research helps further the dialogue regarding student-athletes' academic identity and provide context for factors that contribute to or influence student-athletes' mathematics education.

The study's results, along with those of the pilot study, supported educational research suggesting the existence of a distinct athletic culture (Bell, 2009; Gerdy, 2006; Kissinger & Miller, 2009) within a university setting. Furthermore, the findings support the research that indicated that student' mathematics education experience (Delaney & Madigan, 2009; Hannula, 2002; Middleton & Spanias, 1999; Schiefele & Csikszentmihalyi, 1995), authority figures (Bell, 2009; Delaney & Madigan, 2009; Johnson, 1985; Papanikolaou, et al, 2003; Simons, et al, 2007), support systems (Bell, 2009; Delaney & Madigan, 2009; Koller, et al., 2001; Marx, Huffmon, & Doyle, 2008; Whitner, 1986), and career goals (Delaney & Madigan, 2009; *Life After Sports*, 2007) influenced their engagement and perception of mathematics. Additionally, the disconnect between two mathematics faculty's, a graduate teaching assistant and senior lecturer, perception of mathematics and the mathematics communicated to students in the classroom provided evidence of the misrepresentation of the teaching of mathematics argued by some researchers (Mason & Watson, 2008; Watson, 2008).

While there exists literature (Li & Zhao, 2013; Mason & Watson, 2008; McDermott, 2013; Watson, 2008) that discussed differences between the mathematics educators' and students' perceptions of mathematics, these works refrained from including a description of how these differences develop. The results support the common findings put forth in the literature, but in contrast to these articles the results provide descriptions for how the disconnect between mathematics faculty's and students' perception of mathematics can emerge from certain mathematics curricula. Furthermore, the results give evidence of the frustration a graduate teaching assistance and senior lecturer felt regarding not being able to present their understanding of mathematics due to content demands and pacing constraints of the curricula for some introductory mathematics courses. Additionally, the findings provide evidence of the impact the mathematics curricula has on students' perceptions of mathematics. Thus, this provides evidence of how particular aspects of student-athletes' mathematics education experience can influence their relationship with mathematics.

Contrasting prior research in the culture of student-athletes and factors that contribute to their academic identity, the findings suggested some of these factors had a different influence on student-athletes' academic identity. In particular, the findings provide evidence that student-athletes' teammates are not the negative influence on student-athletes' development of their academic identity suggested by the literature (Gerdy, 2006; Papinkolaou, et al., 2008; Simons, et al., 2007; Tull, 2009). Instead, aligning closer to Bell's (2009) work, the findings demonstrated student-athletes to be a positive voice and example for their fellow student-athletes through the support they provided; establishing academic expectations, encouraging others to meet those expectations, and helping those struggling with classes. Thus, the results provide details regarding the influence that aspects of student-athletes' support systems, in particular their teammates, can have on their academic identity and relationship with mathematics. Furthermore, in contrast to the research of Simons, et al. (2007) that suggested a majority of student-athletes believed their professors viewed them in a negative light the findings examined the mathematics faculty's perception of student-athletes to provide an additional perspective regarding the relationship between student-athletes and academic faculty. Moreover, the results offered a qualitative description depicting how faculty members developed their current perception of student-athletes, providing contrast to the quantitative work of Simons, et al. (2007). The findings provide additional details regarding the relationship student-athletes' have with their authority figures, in particular their mathematics professors.

In addition to the results supplementing and contrasting prior research, the study also offered new ideas regarding how students' may interact with mathematics and apply their mathematical knowledge. The findings gave evidence of a student-athlete's unique use of her mathematical understanding and reasoning that may also be of interest to mathematics education and foreign language education researchers. Kim described her difficulties in her Spanish course that she was taking as part of a foreign language requirement. She explained that she could not make sense of the vocabulary or how to connect ideas. However, once she began to reason in Spanish in the same way she did in mathematics, she started to understand how to work within the foreign language. The idea that mathematics is its own language was not unique to just Kim. Dr. Sheehan also described mathematics in terms of a language, discussing how the mathematical foundations of algebra and geometry taught in high school are the alphabet mathematicians use to create more advanced and elegant mathematical arguments. Thus, the findings suggested the existence of a connection between mathematical reasoning and the understanding of new languages.

Implications for Improving Student-Athletes' Cultural Relationship with Mathematics

One rationale for the study was to investigate student-athletes' relationship with mathematics to determine possible ways to improve student-athletes' engagement of mathematics, and hence improve their overall mathematics education. The findings suggested that student-athletes became engaged in a discussion about mathematics outside of the classroom when they talked about their awareness of mathematics within their respective sports. In these discussions, the student-athletes also conveyed a sense of appreciation for mathematics as it could describe the physical motions of swimming and diving or relate to the strategy within a soccer match. As the two student-athletes with high amounts of mathematical experience both recommended, tapping into to student-athletes' understanding and interest of their sport, and connecting it to mathematics in non-trivial ways, may provide opportunities to engage and encourage student-athletes to become more invested in the field of mathematics. Martin and Guengerich (2000) offered some ideas for this connection at the K-12 level in their textbook *Integrating Math in the Real World: The Math of Sports*. However, more advanced applications of mathematics within sports, such as describing different models of running, while considering the effects of air resistance, fatigue, and duration of grade of surface (Davey, Hayes & Norman, 1994; Pritchard, 1993) or analyzing the strategy of the professional foul within a soccer match (Wright & Hirotsu, 2003), require some creativity and awareness of appropriate context and timing from a mathematics educator to incorporate within their teaching. This follows Herzig's (2005) suggested opportunities for all students to learn mathematics by developing an understanding of student-athletes as individuals, using this knowledge to connect the curriculum to their interests, provide a rich learning opportunity, and finally giving student-athletes a chance to demonstrate their knowledge.

One aspect for the significance of the study was to build a broader base for encouraging students to become involved members of the mathematics community, and thus could aid in preserving the mathematical community by ensuring that it maintains a sustainable number of members. With this consideration an additional implication for improving student-athletes' relationship with mathematics emerged from the findings. The results give evidence that student-athletes' career goals influenced their engagement of mathematics by informing their choice of major, and thus the mathematics courses they enroll. Furthermore, student-athletes' awareness of the career opportunities associated with a mathematics degree could influence their engagement with mathematics. Therefore, the mathematics faculty can actively recruit student-athletes into the mathematics culture by increasing their awareness of possible career goals, beyond that of a mathematics teacher, through either the teaching of introductory and intermediate mathematics or working with the Academic Support. Raising the number of student-athletes' engaging in mathematics may help influence more student-athletes to become active in the mathematics community since the findings of this study and the literature (Calhoun, 2012) suggested that student-athletes can influence the classes their fellow student-athletes enroll in and their perception of mathematics. Thus, after an initial recruitment effort by mathematics faculty, it may be possible to establish a sustainable cycle of student-athletes encouraging other student-athletes to engage in mathematics.

Besides the mathematics faculty simply working together with the athletics department to increase awareness of the opportunities a strong mathematics education can provide student-athletes, there are a number of benefits to developing a collaborative program between the mathematics faculty and athletics department with the goal of improving student-athletes' relationship with mathematics and overall mathematics education. The findings included Allyson's expressed desire to be more involved in the mathematics culture through programs such as becoming a Supplement Instructor for a mathematics class, but her schedule prevented her involvement. The literature (Herzig, 2002; Komarraju, et al., 2010) argued that students' participation and integration with faculty provide students with an increased satisfaction with their academic life, increases persistence, and they become more extrinsically and intrinsically motivated. Thus, the findings and the literature suggest that having mathematics faculty offer student-athletes the opportunity to work alongside or meet to discuss mathematics individually or in small groups at times that work within the schedules of both parties would greatly benefit student-athletes and mathematics faculty alike. Student-athletes would have the chance to develop a better understanding of the culture of mathematics, without the pressure of being assessed in a class setting. Furthermore, the resulting relationships between student-athletes and mathematics faculty will provide student-athletes the opportunity to engage faculty in conversation outside of the classroom, which could benefit them career-wise since faculty provide an additional resource for opinions, knowledge, and expertise outside of their family, coaches, and other support systems (Herzig, 2002). The mathematics faculty would benefit from such a program since it would allow them to better understand the athletic culture within their institution, and establish a greater connection between academics and athletics at the university. It may be argued that it is somewhat idealistic for both the mathematics faculty and student-athletes to meet outside of a classroom setting since there would be little incentive to ensure both parties to attend. Thus, a more realistic option may be to develop a seminar course in similar spirit to the one Dr. Sheehan proposed. Then the mathematics faculty time and energy could benefit both athlete and non-athlete students.

The findings also gave implications for pedagogical practices for mathematics faculty to aid in strengthening the cultural relationship between student-athletes and mathematics. These implications were informed by student-athletes' descriptions of their mathematics education experiences, and would not only help improve mathematics cultural relationship with student-athletes, but with all students engaging in mathematics. The findings provide evidence of disconnect between two mathematics faculty's, a graduate teaching assistant and a senior lecture, perception of mathematics and the mathematics they present to their students in class. This same divide was found in Herzig's (2002) research. The author explained that often faculty described the goals of their teaching as communicating mathematical concepts instead of sharing their understanding and perception of mathematics. This was shown, in both the research results and Herzig's findings, to leave students unmotivated, unaware of the connections within mathematics, and unable to understand the big picture. Therefore, helping students understand how the mathematics community perceived mathematics, may allow them to better understand the mathematics culture and develop their mathematical identities (Grootenboer, 2013). However, Gowers (2000) argued that there is division within the culture of mathematics about what mathematics is, thus presenting a unified understanding of mathematics to students may not be simple.

The literature (Bell, 2009; Kamusoko & Pemberton, 2011; Vallerand, 2004) suggested that student-athletes' authority figures outside of the classroom, in particular their coaches, are well situated to enhance student-athletes' persistence and engagement in their education. The findings support this sentiment, but gave evidence that collegiate coaches were somewhat detached in the influence they had on student-athletes' academic endeavors. However, the findings showed that high school coaches', who were also teachers, active involvement in the education of student-athletes could have a lasting influence in student-athletes' mathematics education. The Academic Support Services provided coaches with some justification for disassociating themselves from their student-athletes' academic responsibilities. Thus, there are implications for getting coaches to become more involved in the academic side of the university.

Limitation of Findings

In the methodology chapter, details are provided regarding the quality of the research by outlining the measure taken to ensure the trustworthiness of the research. Additionally, the scope and transferability of the findings to other settings and populations in regards to the research setting, data collection and procedure for analysis were discussed. In particular, as an exploratory study, which focused on understanding the cultural relationship between student-athletes and mathematics, the research design lacked procedures to provide evidence for effective methods to improve student-athletes' understanding of mathematics. Instead, the composite description of this cultural relationship offered in this dissertation could only build on the literature by detailing factors that contributed to student-athletes' perception and engagement with mathematics.

The following paragraphs present further limitations of the study findings to help contextualize the scope and transferability of the results.

The inclusion of descriptions of both student-athlete and mathematics culture within the results provide evidence of the triangulation of data used to develop the depiction of the student-athletes' and mathematics faculty's experience with this cultural relationship. However, there were some limitations observed during the analysis of interview and observation data that weakened the quality of emergent themes. Student-athletes were questioned about factors that contributed to their overall perception of mathematics; they were not specifically asked about their thoughts regarding how to improve their mathematics education. Similarly with the mathematics faculty, there was an opportunity missed to explore their ideas for improving student-athletes' mathematics education. Outside of Dr. Sheehan's, Allyson's, and Kim's consideration of how to improve student-athletes' mathematics through the reshaping of curricula or the incorporation of students' interest into mathematics, no data were collected specifically from the research participants to answer how to improve student-athletes' mathematics education. Answers to this question from student-athletes with low and moderate amounts of mathematics experience could have provided data to compare and analyze with the themes that emerged relating to factors that they identified to contribute to their perception of mathematics.

The discussion of the findings of the study included reference to several limitations, from the triangulation of data from both student-athlete and mathematics cultures. These included a lack of observational data of a proof-based mathematics course to give a broader description of the mathematics culture and the enculturation process students' experience. Thus, not allowing the chance to track the possibility of longitudinal changes in perception of mathematics during a student-athletes' college tenure. Also, the absence of interview data from non-athlete students prevented examining comparisons between the development of athlete and non-athlete students' perceptions and understandings of mathematics.

Recommendations for Future Research

The design and purpose of this study was to develop an understanding of student-athletes' relationship with mathematics at a Division I university, as well as how they perceived mathematics and how they came to understand mathematics through their experiences, values, and behaviors within their educational institution. Kuh (1990) suggested that "before student cultures can be influenced, they must be discovered and understood" (p. 57). Thus, this research presented a foundational understanding of the cultural relationship between student-athletes and mathematics at a Division I university, which provides individuals, such as mathematics faculty, members of an athletic department, and student-athletes, with information to make educated decisions regarding measures to improve student-athletes' mathematics education. Furthermore, examining past (Pascarella, et al., 1999) and emerging (Gutmann, 2014) research which raised concerns regarding the deficiencies in student-athletes' education in academic disciplines outside of mathematics, there are natural adaptations for future research which incorporate the design of this study to these other subjects to increase the educational diversity and strengthen the overall education of the student-athlete population. In addition to using the framework or methodology of this research for other educational disciplines, the research findings and limitations offer several suggested paths for follow-up studies.

The following paragraphs outline a number of follow-up studies and recommendations that may inspire future research that further delves into the culture of mathematics and adds to the body of research on factors that influence students' (athlete and non-athlete alike) perception and engagement in mathematics culture. These studies include (1) a more focused examination of men's basketball and football players' cultural relationship with mathematics at a Division I university, (2) using a mixed method study to analyze the effectiveness and outcomes of a collaborative program with both an athletics and mathematics department as discussed in earlier in the implications of the findings, (3) an inquiry into the effects of students' increased mathematical experience on their perception of mathematics, and (4) adopting a mixed method approach to investigate if changing the mathematics curriculum to align closer with the mathematics faculty's perception of mathematics, as discussed in the implications of the findings from this study, may influence students' perception, engagement, and performance in mathematics.

Often researchers will look to strengthen the transferability of their findings by conducting a large-scale version of a study across multiple research sites. It can also be beneficial to adopt a prior research design, and then narrow its focus to learn more about a population of interest. While the findings of this study and literature provide evidence of a distinct student-athlete culture within a university, the literature (Pascarella, et al. 1995; Pascarella, et al., 1999) also suggested student-athletes involved in men's basketball or football scored significantly lower on standardized mathematics exams when compared to both their fellow student-athletes and non-athletes. This indicates a need to explore how to improve the mathematics education for men's basketball and football student-athletes. Kuh (1990) suggested that before action can be taken to help these student-athletes' mathematics education, it is necessary to understand the culture for these particular student-athletes. Thus, a study following the design from this dissertation which investigates this culture would aid in building an understanding of how to influence the culture in such a way as to improve student-athletes mathematics education. While concentrating on the culture of student-athletes participating in men's basketball and football, conducting this focused study across multiple research sites would also lend to the transferability of its findings.

One of the implications discussed earlier in this chapter focused on the development of a collaborative program between the mathematics and athletics departments to engage student-athletes more in the mathematics culture. As with the implementation of any program, careful attention must be given to how to measure its effectiveness and outcomes so that the merits of the program may be determined. Employing a mixed methods approach to analyze the program will provide quantitative data, to evaluate its impact on student-athletes' mathematics education, as well as qualitative data, to investigate if the program affects either the mathematics faculty's perception of student-athletes or student-athletes' perception and interest in mathematics. The collection of quantitative data from student-athletes, both participating and not participating in the program, will allow a researcher to establish reference points or benchmarks for student-athletes' prior mathematics performance. This type of data may include data from standardized test scores or the GPA from previous mathematics courses. A researcher would then be able to track student-athletes' performance in subsequent mathematics courses by gathering either exams scores or course grades, while at the same time taking into account the difficulty and content of the mathematics courses. Qualitative data in the form of interviews with participating mathematics faculty and student-athletes may be used to examine how both perceive the program itself, each other, and their perception of mathematics. If a longitudinal study is employed, then it would allow the researcher to analyze for change in perceptions over time. Additionally, a longitudinal study would give the researcher the opportunity to track student-athletes' mathematical retention and persistence.

In the findings there was evidence for differences in student-athletes' perception of mathematics based upon the amount of their mathematical experience. Both student-athletes with high amounts of mathematical experience voiced an appreciation for the beauty and scope of mathematics. None of the student-athletes with low to moderate amounts of mathematical experience expressed their perception of mathematics in quite the same regard. Thus, two questions arise: (1) when in the students' education and what specifically elevated the students' appreciation for mathematics? (2) Which came first, several courses in mathematics or an appreciation for the beauty and scope of the subject? Adopting a longitudinal case study of students pursuing degrees that require the students to enroll in enough mathematics courses to gain a moderate amount of mathematical experience over their college education would allow a researcher to interview the students multiple times during their education to examine their perception and engagement of mathematics and what influenced their ways of thinking about mathematics. A point of interest for this researcher would be to consider parallels between its results and the findings of this study to see if the influence of students' mathematics education experience, support systems, authority figures, and career goals were a source of influence on their perception of mathematics. This would address one of the limitations within this dissertation by providing data to compare athlete and non-athlete students' perception and understanding of mathematics. A natural follow-up to such as study would be to incorporate the findings from the research into lower level mathematics courses to determine its effects on a broader population of students.

Finally, future research could examine the possible disconnect between the mathematics faculty's perception of mathematics and the mathematics presented to their students through a mathematics curriculum as evidenced in the results of this study and discussed in the literature (Mason & Watson, 2008; McDermott, 2013; Watson, 2008). The implications of the findings included a suggested need to reshape the mathematics curriculum such that it may align more with mathematics faculty's perception of mathematics. Thus, if such a shift is implemented it should be studied to examine the impacts it has on students' mathematics education. The use of a mixed method approach would provide a researcher with quantitative data to examine students' performance and qualitative data to observe students' perception of the curriculum change. To carry out such as study it would be critical for members of the mathematics faculty to explicitly identify how the curriculum connects to their perception and understanding of mathematics, as well as identifying students' learning outcomes such as improving students' mathematical content knowledge and developing students' understanding of the nature of mathematics. Initial studies could involve gathering qualitative data through interviews with both mathematics faculty and students. Interviews with mathematics faculty would allow a researcher to gauge the faculty's satisfaction that their understanding and perception of mathematics as being presented through the revised curriculum. Talking with students at different points of a semester, such as within the first two weeks and during the last two weeks, would allow a researcher to investigate the curriculum's effect on students' perception of mathematics or their awareness of applications of mathematics. Furthermore, gathering quantitative data from students' exam scores would give the researcher an opportunity to measure students' mathematical performance. Maintaining some exam questions from a prior mathematics curriculum may also provide the researcher with evidence to examine if the new curriculum benefits students' mathematic performance. While students' exam scores may be used to track students' understanding of mathematics, the inclusion of student interview data allows the researcher to triangulate the data to construct a richer description of students' understanding of mathematics. If a longitudinal study is employed, then it would allow for the analysis of change in perceptions over time. Additionally, a longitudinal study would provide data necessary to track students' mathematical retention and persistence.

References

Adelman, C. (1999). *Answers in the tool box*. US Department of Education, Washington, DC.

Adler, P., & Adler, P. A. (1985). From idealism to pragmatic detachment: The academic performance of college athletes. *Sociology of Education, 58*(4), 241-250.

Adler, P. A., & Adler, P. (1994). Observational techniques. In N. K. Denzin & Y. S. Lincoln (Eds.), H*andbook of Qualitative Research* (pp. 377-392). Thousand Oaks, CA: Sage Publication.

Allen, J. & Robbins, S. B. (2008). Prediction of college major persistence based on vocational interests, academic preparation, and first-year academic performance. *Research in Higher Education, 49*(1), 62–79.

Aries, E., McCarthy, D., Salovey, P., & Banaji, M. R. (2004). A comparison of athletes and non-athletes at highly selective colleges: Academic performance and personal development. *Research in Higher Education, 45*(6), 577-602.

Banks, T. (2008). *Integrated mathematics courses and the NCAA core course system.* Retrieved Sept. 18, 2008, from NCTM Web site: http://www.nctm.org/resources/content.aspx?id=1720

Beilock, S. L., & McConnell, A. R. (2004). Stereotype threat and sport: Can athletic performance be threatened? *Journal of Sport & Exercise Pyschology, 26*, 597-609.

Bell, L. F. (2009). Examining academic role-set influence on the student-athlete experience. *Journal of Issues in Intercollegiatge Athletics*, Special Issue, 19-41.

Bowen, W. G., & Levin, S. A. (2003). *Reclaiming the game: College sports and educational values*. Princeton, NJ: Princeton University Press.

Calhoun, V. A. (2012). *Division I student athletes and the experience of academic clustering* (Unpublished doctoral dissertation). Northeastern University, Boston, MA.

Carter, G. C., & Shannon, J. R. (1940). Adjustment and personality traits of athletes and non-athletes. *The School Review, 48*(2), 127-130.

Civil, M. (2002). Culture and mathematics: A community approach. *Journal of Intercultural Studies*, *23*(2), 133-148.

Clotfelter, C. T. (2011). *Big-time sports in American universities*. New York, NY: Cambridge University Press.

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Creswell, J.W. (2007). *Qualitative inquiry & research design: Choosing among five approaches.* (2nd ed.) Thousand Oaks, CA: Sage Publications.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. London: Sage Publications.

Davey, R. C., Hayes, M., & Norman, J. M. (1994). Running uphill: An experimental result and its application. The Journal of the Operational Research Society, 45(1), 25-29.

Delaney, T., & Madigan, T. (2000). *Sports: Why people love them!* Lanham,MD: University Press of America.

Fontana, A., & Frey, J. H. (1994). Interviewing: The art of science. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 361-376). Thousand Oaks, CA: Sage Publications.

Forbes. (2010). In *America's best colleges* [Fact sheet]. Retrieved January 31, 2012, from http://www.forbes.com/lists/2010/94/best-colleges-10_Americas-Best-Colleges_Rank.html

Gall, M., Gall, J., and Borg, W. (2003). *Educational research an introduction*. (7th ed.) Boston: Pearson Education.

Gerdy, J. R. (2006). *Air ball: American education's failed experiment with elite athletics*. Jackson, MS: University Press of Mississippi.

Gordhamer, R. (n.d.) *10 reasons why college students struggle*. Retrieved October 9, 2008, from Getting Ready For College web site: http://www.gettingreadyforcollege.com/10_Reasons_Why_College_Students_Struggle.pdf

Gowers, W. T. (2000). The two cultures of mathematics. In V. Arnold, M. Atiyah, P. Lax, & B. Mazur (Eds.), *Mathematics: Frontiers and perspectives* (pp. 65-78). American Mathematical Society.

Green, J. J., Stone, C. C., Zegeye, A., & Charles, T. A. (2007). Changes in math prerequisites and student performance in business statistics: Do math prerequisites really matter? *Journal of Economics and Finance Education, 6*(2), 27-38.

Grootenboer, P. (2013). The praxis of mathematics teaching: Developing mathematical identities. *Pedagogy, Culture & Society*, 1-22. http://dx.doi.org/10.1080/14681366.2012.759131

Gutmann, H. (2014, January 15). UNC whistleblower details academic disparities in brief. *Herald Sun*. Retrieved from http://www.heraldsun.com/sports/x318369455/UNC-whistleblower-details-academic-disparities-in-brief

Hamilton, K. (2004). Creating a successful student-athlete. *Black Issues in Higher Education*, *21*(4), 30-31.

Hannula, M. S. (2002). Attitude towards mathematics: Emotions, expectations and values. *Educational Studies in Mathematics, 49*(1), 25-46.

Herzig, A. H. (2002). Where have all the students gone? Participation of doctoral students in authentic mathematical activity as a necessary condition for persistence toward the PH.D. *Educational Studies in Mathematics*, *50*(2), 177-212.

Herzig, A. H. (2005). Goals for achieving diversity in mathematics classrooms. *Mathematics Teacher*, *99*(4), 253-259.

Herzog, S. (2005). Measuring determinants of student return vs. dropout/stopout vs. transfer: A first-to-second year analysis of new freshmen. *Research in Higher Education*, *46*(8), 883-928.

Hewitt, P. M. (2009). The recruiting process: The experiences of student-athletes. In D. B. Kissinger & M. T. Miller (Eds.), *College student-athletes: Challenges, opportunities, and policy implications* (pp. 1-7). Charlotte, NC: Information Age Publishing, Inc.

Hofer, B. K. (2000). Dimensionality and disciplinary differences in personal epistemology. *Contemporary Educational Psychology*, *25*(4), 378-405.

Hofer, B. K., & Pintrich, P. R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research, 67*(1), 88-140.

Horton, D. (2009). Class and cheats: Community college student athletes and academic success. *New Directions for Community Colleges, 147*, 15-27.

Hu, S., & Kuh, G. D. (2003a). Diversity experiences and college student learning and personal development. *Journal of College Student Development*, *44*(3), 320-334.

Hu, S., & Kuh, G. D. (2003b). Maximizing what students get out of college: Testing a learning productivity. *Journal of College Student Development*, *44*(2), 185-203.

Humphrey, J. H., Yow, D. A., & Bowden, W. W. (2000). *Stress in college athletics: Causes, consequences, coping*. New York, NY: The Haworth Half-Court Press.

Hyde, J. S., & Mertz, J. E. (2009). Gender, culture, and mathematics performance. *Proceedings of the National Academy of Sciences of the United States of America, 106*(22), 8801-8807.

Johnson, D. Q. (1985). Misguided student athletes: An application of contract theory. *Columbia Law Review, 85*(1), 96-129.

Kamusoko, S. D., & Pemberton, C. L. A. (2011). Student-athlete wellbeing and higher education persistence. *Journal of Issues in Intercollegiate Athletics*, *4*, 207-235.

Kissinger, D. B., & Miller, M. T. (2009). The contemporary college student-athlete as a subpopulation. In D. B. Kissinger & M. T. Miller (Eds.), *College student-athletes: Challenges, opportunities, and policy implications* (pp. 1-7). Charlotte, NC: Information Age Publishing, Inc.

Koller, O., Baumert, J., & Schnabel, K. (2001). Does interest matter? The relationship between academic interest and achievement in mathematics. *Journal for Research in Mathematics Education, 32*(5), 448-470.

Komarraju, M., Musulkin, S., & Bhattacharya, G. (2010). Role of student-faculty interactions in developing college students' academic self-concept, motivation, and achievement. *Journal of College Student Development*, *51*(3), 332-342.

Kuh, G. D. (1990) Assessing student culture. In W. G. Tierney, (Ed.) *Assessing Academic Climates and Cultures* (pp. 47-60). San Francisco: Jossey-Bass.

Ladson-Billings, G. (1997). It doesn't add up: African American students' mathematics achievement. *Journal for Research in Mathematics Education*, *28*(6), 697-708.

Lapchick, R. E. (Ed.). (2006). *New game plan for college sport*. Westport, CT: Praeger Publishers.

Lerman, S. (2001). Cultural, discursive psychology: A sociocultural approach to study the teaching and learning of mathematics. *Educational Studies in Mathematics, 46*, 87-113.

Lesik, S. A. (2007). Do developmental mathematics programs have a casual impact on student retention? An application of discrete-time survival and regression-discontinuity analysis. *Research in Higher Education*, *48*(5), 583-608.

Li, H., & Zhao, D. (2013). The penetration of mathematical culture in teaching mathematics. *Studies in Mathematical Sciences*, *6*(2), 118-121.

Life after sports: Overview. (2007). Retrieved October 29, 2008, from http://www.lifeaftersports.org/overview.php

Malloy, C. E., & Malloy, W. W. (1998). Issues of culture in mathematics teaching and learning. *The Urban Review*, *30*(3), 245-257.

Maloney, M. T., & McCormick, R. E. (1993). An examination of the role that intercollegiate athletic participation plays in academic achievement: Athletes' feats in the classroom. *The Journal of Human Resources*, *28*(3), 555-570.

Mason, J., & Watson, A. (2008). Mathematics as a constructive activity: Exploiting dimensions of possible variation. In *Making the connection: Research and teaching in undergraduate mathematics education* (pp. 191-204). United States of America: The Mathematical Association of America.

Martin, H., & Guengerich, S. (2000). *Integrating Math in the Real World: Vol. 3. The math of sports: Integrating math in the real world*. Portland, ME: J Weston Walch.

Marx, J., Huffmon, S., & Doyle, A. (2008). The student-athlete model and the socialization of intercollegiate atheles. *Athletic Insight*, *10*(1). Retrieved October 20, 2008, from http://www.athleticinsight.com/Vol10Iss1/StudentAthleteModel.htm

McDermott, R. (2013). When is mathematics, and who says so?: A commentary on part I. In B. Bevan, P. Bell, R. Stevens, & A. Razfar (Eds.), *Explorations of Educational Purpose: Vol. 23. LOST opportunities* (pp. 85-91). Springer.

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco: Jossey-Bass A Wiley Imprint.

Middleton, J. M., & Spanias, P. A. (1999). Motivation for achievement in mathematics: Findings, generalizations, and criticisms of the research. *Journal for Research in Mathematics Education, 30*(1), 65-88.

Morris, A. (2009). Private college student-athletes: The world of D3 and NAIA. In D. B. Kissinger & M. T. Miller (Eds.), *College student-athletes: Challenges, opportunities, and policy implications* (pp. 1-7). Charlotte, NC: Information Age Publishing, Inc.

Moustakas, C. (1994). *Phenomenological research methods*. Thousand Oaks, CA: Sage Publications.

Muis, K. R. (2004). Personal epistemology and mathematics: A critical review and synthesis of research. *American Educational Research Association, 74*(3), 317-377.

National Collegiate Athletic Association. (2011). *Differences among the three division: Division I*. Retrieved from NCAA website: http://www.ncaa.org/wps/wcm/connect/public/NCAA/About+the+NCAA/Who+We+Are/Differences+Among+the+Divisions/

National Collegiate Athletic Association. (2010). *History*. Retrieved from NCAA website: http://www.ncaa.org/wps/wcm/connect/public/ncaa/about+the+ncaa/who+we+are/about+the+ncaa+history

National Collegiate Athletic Association. (2007). *NCAA freshman-eligibility standards quick reference sheet.* Retrieved Sept. 18, 2008, from NCAA website: http://www.ncaa.org/wps/wcm/connect/resources/file/eb1afe0c529230b/Quick_Reference_Sheet_for_IE_Standards-5-2-08.pdf?MOD=AJPERES

National Council of Teachers of Mathematics.(2000). *Principles and standards for school Mathematics*. Portland, Oregon: Graphics Arts Center.

Papanikolaou, Z., Nikolaidis, D., Patsiaouras, A., & Alexopoulos, P. (2003). The freshman experience: High stress – low grades. *Athletic Insight*, *5*(4). Retrieved October 8, 2008, from http://www.athleticinsight.com/Vol5Iss4/Commentary.htm

Pascarella, E. T. (2006). How college affects students: Ten directions for future research. *Journal of College Student Development*, *47*(5), 508-520.

Pascarella, E. T., Bohr, L., Nora, A., & Terenzini, P. T. (1995). Intercollegiate athletic participation and freshman-year cognitive outcomes. *The Journal of Higher Education*, *66*(4), 369-387.

Pascarella, E. T., Truckenmiller, R., Nora, A., Terenzini, P.T., Edison, M., & Hagedorn, L. S. (1999). Cognitive impacts of intercollegiate athletic participation: some further evidence.*The Journal of Higher Education*, *70*(1), 1-26.

Patton, M. Q. (2002). *Qualitative research & evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Pfister, V. R. (2004). *Effects of faculty and peer mentoring on perceived stress and social support of college student athletes* (Doctoral dissertation, University of South Florida, Tampa, FL). Retrieved from Scholar Commons database. (Paper 1195)

Pike, G. R., Kuh, G. D., & Gonyea, R. M. (2003). The relationship between institutional mission and students' involvement and educational outcomes. *Research in Higher Education*, *44*(2), 241-261.

Powers, E. (2008). Scholars and sports. *Inside Higher Ed*. Retrieved from http://www.insidehighered.com/news/2008/01/11/ncaa.

Pozo, S., & Stull, C. A. (2006). Requiring a math skills unit: Results of a randomized experiment. *The American Economic Review, 96*(2), 437-441.

Pritchard, W. G. (1993). Mathematical models of running. SIAM Review, 35(3), 359-379

Ridpath, B. D. (2002). *NCAA Division I student athlete characteristics as indicators of academic achievement and graduation from college* (Unpublished doctoral dissertation). West Virginia University, Morgantown, WV.

Roach, R. (2004). Academics and athletics: Playing for the same team. *Black Issues in Higher Education*, *21*(4), 26-31.

Roberson, L., Capels, D., & Yacoub, W. (2009). *Athletes to mathletes: Factors influencing student-athletes mathematical experiences*. Unpublished manuscript, University of Northern Colorado, Greeley, CO.

Roberson, L. (2009). *The search for athletic mathletes: The lack of connections between mathematics and collegiate athletics*. Unpublished manuscript, University of Northern Colorado, Greeley, CO.

Schiefele, U., & Csikszentmihalyi, M. (1995). Motivation and ability as factors in mathematics experience and achievement. *Journal for Research in Mathematics Education*, *26*(2), 163-181.

Schoenfeld, A. H. (2000). Purpose and methods of research in mathematics education. *Notices of the AMS, 47*(6), 641-649.

Sierpinska, A., & Lerman, S. (1996). Epistemologies of mathematics and of mathematics education (K. Clements, Ed.). In *International Handbook of Mathematics Education* (pp. 827-876). Netherlands: Kluwer Academic Publishers.

Sperber, M. (2001). *Beer and circus: How big-time college sports is crippling undergraduate education*. New York, NY: Henry Holt and Company.

Simons, H. D., Bosworth, C., Fujita, S., & Jensen, M. (2007). The athlete stigma in higher education. *College Student Journal*, *41*(2), 251-273.

Snoddy, M. L., & Shannon, J. R. (1939). Standardized achievement measurements of athletes and non-athletes. *The School Review*, *47*(8), 610-612.

Stage, F. K., & Kloosterman, P. (1995). Gender, beliefs, and achievement in remedial college-level mathematics. *The Journal of Higher Education*, *66*(3), 294-311.

Stigler, J. W., & Barnes, R. (1988-1989). Culture and mathematics learning. *Review of Research in Education*, *15*, 253-306.

Stinson, D. W. (2006). African American male adolescents, schooling (and mathematics): Deficiency, rejection, and achievement. *Review of Educational Research, 76*(4), 477-506.

Thamel, P. (2006, November 4). Athletes get new college pitch: Check out our tutoring center. *New York Times*.

Thelin, J. R. (1996). *Games colleges play: Scandal and reform in intercollegiate athletics*. Baltimore, MD: The Johns Hopkins University Press.

Tillman, L. C. (2002). Culturally sensitive research approaches: An African-American perspective. *American Educational Research Association, 31*(9), 3-12.

Tull, A. (2009). Involvement in learning and athletic participation. In D. B. Kissinger & M. T. Miller (Eds.), *College student-athletes: Challenges, opportunities, and policy implications* (pp. 73-89). Charlotte, NC: Information Age Publishing, Inc.

Vallerand, R. J. (2004). Intrinsic and extrinsic motivation in sport. In C. D. Spielberger (Ed.), *Encyclopedia of applied psychology* (Vol. 2, pp. 427-435). Academic Press.

von Glasersfeld, E. (1995). *Radical constructivism: A way of knowing and learning*. Washington, DC: The Falmer Press.

Walker, E. N. (2006). Urban high school students' academic communities and their effects on mathematics success. *American Educational Research Journal, 43*(1), 43-73.

Watson, A. (2008). School mathematics as a special kind of mathematics. *For the Learning of Mathematics, 28*(3), 3-7.

Whitner, P. A., & Myers, R. C. (1986). Academics and an athlete: A case study. *The Journal of Higher Education, 57*(6), 659-672.

Wolcott, G. V., & Gore-Mann, D. (2009). The cycle of transition for student-athletes to college. In D. B. Kissinger & M. T. Miller (Eds.), *College student-athletes: Challenges, opportunities, and policy implications* (pp. 73-89). Charlotte, NC: Information Age Publishing, Inc.

Wright, M. & Hirotsu, N. (2003). The professional foul in football: Tactics and deterrents. *The Journal of the Operational Research Society, 54*(3), 213-221.

Yost, M. (2010). *Varsity green: A behind the scenes look at culture and corruption in college athletics*. Stanford, CA: Stanford University Press.

APPENDIX A

COURSE DESCRIPTIONS FOR REQUIRED MATHEMATICS COURSES

***Problem Solving* -** For students not planning to enroll in a College Algebra or calculus course. Examines modern topics chosen for their applicability and accessibility. Provides students with mathematical and logical skills needed to formulate, analyze and interpret quantitative arguments in a variety of settings. Introduces statistics and stresses the use of a calculator.

***Finite Mathematics* -** Introduces finite mathematics for majors not requiring calculus. Includes matrix algebra, Gaussian elimination, set theory, permutations, probability and expectation.

***College Algebra* -** Emphasizes aspects of algebra important in the study of calculus. Includes notation of algebra, exponents, factoring, theory of equations, inequalities, functions, graphing and logarithms. For students who plan to enroll in a calculus course.

Three Course Sequence for to Satisfy Mathematics Requirement for Elementary Education Teachers

***First Course* –** For prospective elementary school teachers. The purpose is to prepare students to be competent in teaching the major concepts and skills related to the real numbers and four arithmetic operations. Includes focus on subsets of the real number system, including natural, integer, and rational numbers.

***Second Course* –** continuation of the first course for prospective elementary teacher. Emphasis is on asking and answering critical questions about the world through algebra, probability, and data analysis to prepare students to be competent in teaching these major concepts.

***Third Course* -** Continuation of the second course for prospective elementary teachers; emphasis is on asking and answering critical questions about spatial reasoning as evident in the real world. Includes investigations of two- and three-dimensional shapes and their properties, measurements, constructions, and transformations to prepare students to be competent in teaching these concepts.

APPENDIX B

INSTITUTIONAL REVIEW BOARD APPROVAL

UNIVERSITY *of*
NORTHERN COLORADO

Institutional Review Board

May 3, 2012

TO: Gary Heise
School of Sport and Exercise Science

FROM: The Office of Sponsored Programs

RE: Exempt Review of *Building Bridges: Connecting Collegiate Athletic and Mathematic Cultures,* submitted Lee Roberson (Research Advisor: Bill Blubaugh)

The above proposal is being submitted to you for exemption review. When approved, return the proposal to Sherry May in the Office of Sponsored Programs.

I recommend approval.

Gary D. Heise 19 July 2012

Signature of Co-Chair Date

The above referenced prospectus has been reviewed for compliance with HHS guidelines for ethical principles in human subjects research. The decision of the Institutional Review Board is that the project is exempt from further review.

IT IS THE ADVISOR'S RESPONSIBILITY TO NOTIFY THE STUDENT OF THIS STATUS.

Comments: emailed questions 5/18/2012
emailed Maria for advice 5-23-2012
spoke w/ Maria 5-24
emailed ALL 5-24
emailed me 6/6/2012
emailed Lee 6/20/2012

25 Kepner Hall ~ Campus Box #143
Greeley, Colorado 80639
Ph: 970.351.1907 ~ Fax: 970.351.1934

APPENDIX C

MATHEMATICAL EXPERIENCE QUESTIONAIRE

Directions: The purpose of the research is to investigate the nature of the culture of collegiate student-athletes' in relationship to the culture of mathematics at a Division I university. During the course of the research I will interview student-athletes and observe situations where student-athletes may interact with mathematics.

In this questionnaire, I will ask about the amount of mathematics and mathematic-related courses you have participated in while in college and the level of these mathematics and mathematic-related courses. Mathematics-related courses are those involving some amount of mathematical procedures or knowledge in their content. Some examples of mathematics-related courses are physics, economics, and statistics.

The purpose of this questionnaire is to determine the level of your mathematical exposure. Do not hesitate to ask questions if you are unsure what I am asking. If at any time, you feel uncomfortable with a question you do not have to answer it. You may also stop or withdraw from the questionnaire at any time. Do you have any questions or concerns before we start?

Name:____

Year (circle one): **Freshman** **Sophomore** **Junior** **Senior**

1. Current major:

2. Did you ever consider mathematics or a mathematics-related major in college?

3. How many mathematics courses or mathematics-related courses have you enrolled in during college?

4. List these courses.

5. How many mathematics courses or mathematics-related courses do you intend to complete while in college?

6. List these courses.

7. If you are willing to participate in an interview, please leave your contact information below. I will contact you to schedule a time and place that are convenient for you. Note that the interview may take between 45 minutes to one hour to complete.

APPENDIX D

STUDENT-ATHLETE SAMPLE INTERVIEW QUESTIONS

Directions: This audio-recorded interview will last approximately 45 minutes to one hour. During this interview, I am going to ask you some questions related to your educational experiences with mathematics, to your perception of mathematics, and to your educational and career goals. Please elaborate on your response as much as possible. Do not hesitate to ask questions if you are unsure what I am asking. If at any time, you feel uncomfortable with a question you do not have to answer it. You may also stop or withdraw from an interview at any time. Do you have any questions or concerns before we start?

1. How would you describe being in college?
2. What do you see as your role as a student-athlete within your university?
3. How did you develop this role?
4. Can you explain your choice of major?
5. How has mathematics influenced your educational goals?
6. What is your perception of mathematics?
7. What factors have influenced your perception of mathematics? How so?
8. Can you describe your relationship with the faculty at your university?
9. What is your perception of the other students in your classes?
10. What has been your experience with mathematics, both inside and outside of school?
11. Have these experienced changed as you have progressed in your education?
12. How have your teachers, parents, or coaches influenced your perception, interest, or engagement of mathematics?
13. What kind of support have you received from your teammates, athletic department, peers, sport, etc. that have influenced your perception, interest, or engagement of mathematics? How has this support influenced you?
14. What are your career goals? Have these goals influenced your perception, interest, or engagement of mathematics?
15. What aspects of your mathematical education that you have found most stressful? Why?
16. What aspects of your mathematical education have brought you the most satisfaction? Why?

APPENDIX E

CONNECTING RESEARCH CONSTRUCTS TO SAMPLE INTERVIEW QUESTIONS FOR STUDENT-ATHLETES

Sample Interview Question	*Construct*
1. How would you describe being in college?	Culture / Identity
2. What do you see as your role as a student-athlete within your university?	Culture / Identity
3. How did you develop this role?	Culture / Identity
4. Can you explain your choice of major?	Exploratory
5. How has mathematics influenced your educational goals?	Exploratory
6. What is your perception of mathematics?	Exploratory
7. What factors have influenced your perception of mathematics? How so?	Exploratory
8. Can you describe your relationship with the faculty at your university?	Culture / Authority Figures
9. What is your perception of the other students in your classes?	Culture / Support System
10. What has been your experience with mathematics, both inside and outside of school?	Educational Experience
11. Have these experienced changed as you have progressed in your education?	Educational Experience

Sample Interview Question	*Construct*
12. How have your teachers, parents, or coaches influenced your perception, interest, or engagement of mathematics?	Authority Figures
13. What kind of support have you received from your teammates, athletic department, peers, sport, etc. that have influenced your perception, interest, or engagement of mathematics? How has this support influenced you?	Support System / Identity
14. What are your career goals? Have these goals influenced your perception, interest, or engagement of mathematics?	Career Goals / Identity
15. What aspects of your mathematical education that you have found most stressful? Why	Educational Experience / Identity
16. What aspects of your mathematical education have brought you the most satisfaction? Why?	Educational Experience / Identity

APPENDIX F

MATHEMATICS FACULTY SAMPLE INTERVIEW QUESTIONS

Directions: The purpose of the research is to investigate the nature of the culture of collegiate student-athletes' in relationship to the culture of mathematics at a Division I university.
This audio-recorded interview will last approximately 45 minutes to one hour. During this interview, I am going to ask you some questions related to your professional mathematical teaching experiences with student-athletes and perceptions of the culture of your mathematics department. Please elaborate on your response as much as possible. Do not hesitate to ask questions if you are unsure what I am asking. If at any time, you feel uncomfortable with a question you do not have to answer it. You may also stop or withdraw from an interview at any time. Do you have any questions or concerns before we start?

1. How would you describe your teaching philosophy?

2. How do you implement this philosophy in your teaching practice?

3. How do your teaching practices change depending on the courses that you teach?

4. How would you describe your interactions with students inside and outside the classroom?

5. What do you see as the mathematics department's role within the university?

6. How does mathematics department fulfill this role?

7. How do you, as an instructor, attempt to improve students' performance and participation in mathematics courses?

8. How do you account for individual student's needs with your classroom practices?

9. How do you think that the university can help improve students' performance and participation in mathematics courses?

10. What is your perception of the role of student-athletes within the university?

APPENDIX G

ATHLETIC DEPARTMENT STAFF SAMPLE INTERVIEW QUESTIONS

Directions: The purpose of the research is to investigate the nature of the culture of collegiate student-athletes' in relationship to the culture of mathematics at a Division I university.
This audio-recorded interview will last approximately 45 minutes to one hour. During this interview, I am going to ask you some questions related to your professional experiences with student-athletes, non-athletes, academic faculty, and other athletic department staff. Please elaborate on your response as much as possible. Do not hesitate to ask questions if you are unsure what I am asking. If at any time, you feel uncomfortable with a question you do not have to answer it. You may also stop or withdraw from an interview at any time. Do you have any questions or concerns before we start?

Questions for Athletic Director/Head of Academics/Head of Tutoring

1. Can you explain the duties of your position?
2. How do you perceive your role within the university?
3. What do you see as your role in the student-athletes' experience at the university?
4. What is the academic faculty's perception of the athletic department within the university?
5. What is the purpose of the Academic Support Services?
6. How was the academic support services created and funded?
7. How has the academic and support services evolved or changed over time?
8. How do you influence or impact student-athletes' academic endeavors?

Questions for Coaches

1. Can you explain the duties of your position?
2. How do you perceive your role within the university?
3. What do you see as your role in the student-athletes' experience at the university?
4. How have these roles evolved or changed over time?
5. Can you describe an average week for student-athletes during your season? How does this week change for your student-athletes during the off-season?
6. What is the academic faculty's perception of the student-athletes within the university?
7. How do you influence or impact student-athletes' academic endeavors?

APPENDIX H

INFORMED CONSENT FOR
STUDENT-ATHLETE
PARTICIPATION IN RESEARCH

UNIVERSITY *of*
NORTHERN COLORADO

Project Title: Building Bridges: Connecting Collegiate Athletic and Mathematic Cultures
Lead Researcher: Lee Roberson, UNC School of Mathematical Sciences,
lee.roberson@unco.edu, (970)351-2229
Research Supervisor: Dr. Bill Blubaugh, UNC School of Mathematical Sciences,
bill.blubaugh@unco.edu, (970)351-2028

I am conducting research examining the nature of the culture of collegiate student-athletes' in relationship to the culture of a mathematics department at a Division I university. Through this study, I intend to explore how this relationship and various perceptions are developed. I would like to understand and portray your attitudes, interests, motivations, and perceptions of mathematics, as well as your perception and understand of the culture of student-athletes within your university.

In order to understand your mathematical experience, I would like you to complete a questionnaire during the spring of 2011. In this questionnaire, I will be asking about the number and level of mathematics courses you have taken while in college. The purpose of this questionnaire is to determine the level of your mathematical exposure. If you are willing, I may also ask you to participate in one to three interviews scheduled later.

During this interviews, I will ask you some questions regarding your perception of your identity as a student-athlete within your university, educational experiences with mathematics, perception of mathematics, and your educational and career goals. I will audio record the interview so that I may later transcribe it. The information collected from these interviews will only be available to the interview participant, primary researcher, and the research advisor.

If you agree to participate in this study, you may choose to stop participating at any time. Your participation in this study may contribute to your self-awareness about your relationship with mathematics.

To ensure your confidentiality, after all the data is gathered your name will be replaced with a pseudonym. Your name will not appear in any professional report of this research. All original written data will be kept in a locked file cabinet in Lee Roberson's office at the University of Northern Colorado or at his home residence. The audio data will be stored on Lee Roberson's home personal computer, which only he has access. The only person that will have access to this data is Lee Roberson. Please feel free to contact Lee Roberson if you have any questions or concerns about this research at lee.roberson@unco.edu.

Participation is voluntary. If you do choose to participate, you will not be identifiable in final report(s) about the study. You may decide not to participate in this study and if you begin participating, you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Having read the above and having an opportunity to ask any further questions, please sign below if you would like to participate in this research. A copy of this form will be provided to you to hold onto for future reference. If have any concerns about your selection or treatment as a participant, please contact the Sponsored Programs and Academic Research Center, Kepner Hall, University of Northern Colorado, Greeley, CO 80639; (970)351-1907.

Thank you for your assistance in this study.

_____________________________ ________________________ ______
Participant's Name (please print) Participant's Signature Date

________________________ ____________
Researcher's Signature Date

________________________ ____________
Researcher Supervisor's Signature Date

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Participant's Initials: Page 2 of 2

APPENDIX I

INFORMED CONSENT FOR MATHEMATICS FACULTY PARTICIPATION IN RESEARCH

UNIVERSITY of NORTHERN COLORADO

Project Title: Building Bridges: Connecting Collegiate Athletic and Mathematic Cultures
Lead Researcher: Lee Roberson, UNC School of Mathematical Sciences, lee.roberson@unco.edu, (970)351-2229
Research Supervisor: Dr. Bill Blubaugh, UNC School of Mathematical Sciences, bill.blubaugh@unco.edu, (970)351-2028

I am conducting research examining the nature of the culture of collegiate student-athletes' in relationship to the culture of a mathematics department at a Division I university. Through this study, I intend to explore how this relationship and various perceptions are developed. I would like to understand and portray your perceptions and understanding of the mathematics culture at your university, as well as understand your classroom practices and interactions with university students.

If you agree to participate in this study, you may choose to stop participating at any time. Your participation in this study may contribute to your self-awareness about your relationship with the students at your university. Participation in this study will include one to three interviews and observations of your interactions with students in your normal classroom environment.

During these interviews, I will ask you some questions regarding your perception of the mathematical culture within the university, teaching practices, and your interactions with university students. The purpose of these interviews is to question the mathematics faculty about their understanding of the mathematical and student cultures at the university, as well as understanding their interactions with university students. I will audio record the interviews so that I may later transcribe them. The information collected from these interviews will only be available to the interview participant, primary researcher, and the research advisor.

In addition to the interviews, I will conduct observations of your classroom environments and instructional practices. In attempts to construct a complete picture of you classroom practices I will observe your classes at least twice a week for the fall 2012 semester. The purpose of these observations is to gather supporting evidence and context for information I gather from my interviews. These observations will allow me to develop a structural description of the situations and environment that members of the mathematics department interact with students. I may also conduct informal discussions with students in enrolled in the courses outside of the class to gather their perspectives on what I witness during class meetings.

To ensure your confidentiality, after all the data is gathered your name will be replaced with a pseudonym. Your name will not appear in any professional report of this research. All original written data will be kept in a locked file cabinet in Lee Roberson's office at the University of Northern Colorado or at his home residence. The audio data will be stored on Lee Roberson's home personal computer, which only he has access. The only person that will have access to this data is Lee Roberson. Please feel free to contact Lee Roberson if you have any questions or concerns about this research at lee.roberson@unco.edu.

Participation is voluntary. If you do choose to participate, you will not be identifiable in final report(s) about the study. You may decide not to participate in this study and if you begin participating, you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Having read the above and having an opportunity to ask any further questions, please sign below if you would like to participate in this research. A copy of this form will be provided to you to hold onto for future reference. If have any concerns about your selection or treatment as a participant, please contact the Sponsored Programs and Academic Research Center, Kepner Hall, University of Northern Colorado, Greeley, CO 80639; (970)351-1907.

Thank you for your assistance in this study.

Participant's Name (please print) Participant's Signature Date

Researcher's Signature Date

Researcher Supervisor's Signature Date

APPENDIX J

INFORMED CONSENT FOR ATHLETIC DEPARTMENT STAFF PARTICIPATION IN RESEARCH

UNIVERSITY of NORTHERN COLORADO

Project Title: Building Bridges: Connecting Collegiate Athletic and Mathematic Cultures
Lead Researcher: Lee Roberson, UNC School of Mathematical Sciences, lee.roberson@unco.edu, (970)351-2229
Research Supervisor: Dr. Bill Blubaugh, UNC School of Mathematical Sciences, bill.blubaugh@unco.edu, (970)351-2028

I am conducting research examining the nature of the culture of collegiate student-athletes' in relationship to the culture of a mathematics department at a Division I university. Through this study, I intend to explore how this relationship and various perceptions are developed. I would like to understand and portray your perceptions and understanding of the student-athlete culture at your university and the student-athletes' relationships with academic faculty, as well as understand your interactions with university student-athletes.

If you agree to participate in this study, you may choose to stop participating at any time. Your participation in this study may contribute to your self-awareness about your relationship with the students at your university.

During this interview, I will ask you some questions regarding your perception of student-athletes' culture and identity within your university, as well as I will also pose questions regarding your relationship and interactions with student-athletes. The purpose of these interviews is to question athletic department staff members about their perceptions and understanding of the student-athlete culture within the university and the student-athletes' relationships with academic faculty, as well as understand their interactions with university student-athletes. I will audio record the interview so that I may later transcribe it. The information collected from these interviews will only be available to the interview participant, primary researcher, and the research advisor.

To ensure your confidentiality, after all the data is gathered your name will be replaced with a pseudonym. Your name will not appear in any professional report of this research. All original written data will be kept in a locked file cabinet in Lee Roberson's office at the University of Northern Colorado or at his home residence. The audio data will be stored on Lee Roberson's home personal computer, which only he has access. The only person that will have access to this data is Lee Roberson.

Please feel free to contact Lee Roberson if you have any questions or concerns about this research at lee.roberson@unco.edu.

Participation is voluntary. If you do choose to participate, you will not be identifiable in final report(s) about the study. You may decide not to participate in this study and if you begin participating, you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Having read the above and having an opportunity to ask any further questions, please sign below if you would like to participate in this research. A copy of this form will be provided to you to hold onto for future reference. If have any concerns about your selection or treatment as a participant, please contact the Sponsored Programs and Academic Research Center, Kepner Hall, University of Northern Colorado, Greeley, CO 80639; (970)351-1907.

Thank you for your assistance in this study.

Participant's Name (please print) Participant's Signature Date

Researcher's Signature Date

Researcher Supervisor's Signature Date