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Learning Preferences and Perceptions of Undergraduate Mathematics Tutees

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LEARNING PREFERENCES AND PERCEPTIONS OF UNDERGRADUATE MATHEMATICS TUTEES

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The large number of students at postsecondary education institutions who are not college ready has increased the need for learning assistance programs. Tutoring programs are common at many such schools; however, the effect of tutoring students in modern schools is inconclusive. There is some evidence that tutoring helps students learn material they would be unable to learn otherwise, and other evidence suggests tutoring has no influence on academic performance. Considering the lack of consistent evidence to support tutoring programs, why is there still a high demand for them? The answer may include the students' learning style and/or perception of the tutoring environment. Learning style is the way the student takes in new information or the way a student behaves in a learning experience. The learning environment includes the aesthetics and interactions within the tutoring setting.

Not much is known about students who regularly seek out tutoring. The purpose of this quantitative study is to investigate correlations between the number of hours spent in tutoring, the learning styles of undergraduate mathematics students, and the perceptions these students have of their tutoring environments. This is a quantitative study investigating correlations among learning style, perception of the tutoring environment, and hours spent in tutoring. The students' learning styles was measured using the Index of Learning Styles based on the Felder Silverman Learning Style Model. The number of hours spent in tutoring, and the perception of the tutoring environment was measured with a self-report survey. The data was coded using the Statistical Package for the Social Sciences. A principle components analysis was done on the environment measures and correlation tests were run to investigate the interaction of learning style, environment, and hours spent in tutoring.

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This chapter addresses the need for learning assistance in postsecondary institutions, followed by a brief description of the various learning assistance programs common to these schools. Next, the particular learning assistance of tutoring will be explored. The chapter will conclude with an examination of learning style theory and its role in education.

Context of the Study

A report by the college admissions testing service ACT (2012) found that only 24% of the 2012 high-school graduates tested met the benchmark for college readiness in the four core areas of English, reading, mathematics, and science (p. 4). The high number of high-school graduates who are not considered college ready is not new. Boylan and White (1994) found the trend of high school graduates that are not college ready dates back to the late 19th century. Following the civil war when “an unprecedented period of growth took place in the number and variety of higher education institutions” (p. 5), the number of unprepared students grew as these institutions grew. ACT (2012) found only 48% of tested high-school graduates were considered college ready in mathematics.

According to Grady and Carter (2001), there has always been a need for “some type of instructional support for college students as they pursue their individual educational programs” (p. 431). Learning assistance programs have been designed at the postsecondary level to support students adjusting to the college level of work (Arendale, 2010). Post-secondary institutions offer a variety of learning assistance such as “tutorial programs, peer study groups, study strategy workshops, computer-based learning modules, or drop-in learning centers” (Arendale, 2010, para. 2). These programs are intended to help students who otherwise may not succeed in post-secondary education. Developmental courses themselves are considered learning assistance, as are many “noncredit activities such as tutorial programs” (p. 1). Learning assistance in the form of tutoring is the focus of this study.

Post-secondary tutoring in the United States was used as far back as the 1600s when Harvard and Yale provided private tutors for students who were preparing to take entrance exams (Arendale, 2010). Once students were admitted, each student was typically given tutors to use throughout their studies. Tutoring was provided for many classes and for almost every student. Other schools soon started doing the same. At the time, these postsecondary students were typically from wealthy families; so rather than not admitting unprepared students, schools could make more money by admitting students who were not prepared for college and providing them with tutors.

“In many colleges today, tutoring continues to be an integral part of academic support programs” (Rheinheimer, Grace-Odeleye, Francois, & Kusorgbor, 2010, p. 25). Providing such services can be beneficial for both the institutions and the students (Arendale, 2010). By providing tutoring services the schools are able to promote higher academic standards, and increase access to their institution, while the students are able to obtain the help needed to meet the expectations of the institution.

In spite of the long tradition of tutoring, the effect of tutoring on student achievement is inconclusive. Many studies have reported positive effects on college student learning (Baker, Rieg, & Clendaniel, 2006; McDuffie, Mastorpieri, & Scruggs, 2009; Topping & Watson, 1996; Xu, Hartman, Uribe, & Mencke, 2001). However, other studies have found that tutoring students has no significant effect (Deke, Dragoset, Bogen, & Gill 2012; Greenwood & Terry, 1993; Kenny & Faunce, 2004).

The question arises as to why the demand for tutoring is still high if there is evidence to question its effectiveness. Using student evaluations and focus groups, Dvorak (2001) found that tutors were reported as most effective if they displayed sensitivity and caring for their students and served as role models. From Dvorak's study one may ask whether students continue to use tutoring because these aspects of tutoring make students more comfortable or encourage persistence in learning.

In Wong, Chan, Chou, Heh, Tung's 2003 study, a human tutor, virtual tutor, or a computerized assistance program tutored Taiwanese college tutees. The tutees reported that they were more devoted to the human tutors, and that the human tutors challenged them the most (p. 425). The human tutors working alone provided higher flexibility and lower authority than using computer assistance alone or a combination of the two. Subjects also reported that communicating was more flexible when using only a human tutor. However, despite preference for the human tutors, the subjects stated that the most effective learning was done when the tutor was used in combination to the computer program.

Some students do not use tutoring and, in fact, prefer to learn by themselves (Dunn, Beaudry, & Klavas, 1989). This difference in the way students prefer to learn may be explained by learning styles. An individual's learning style has to do with the way that person works with the environment while learning (Popescu, 2010). Learning style is the way the student behaves when encountering a learning experience, the way the student obtains new information or skills (Sarasin, 1999). For example, one person's style may include the need to discuss new concepts with others for comprehension, while another person learns better alone. It does not mean that these two people will not gain the same level of understanding, but how they go about getting that understanding is different.

Another aspect that may have an effect on tutoring use is how students feel about a particular tutoring environment. Many scholars recommend creating a comfortable learning environment (Bosch, 2006; Marland & Rogers, 1997; Rabow, Chin, & Fahimian, 1999; Simmons, 2002), but whether this makes a quantifiable difference in tutoring use is unknown.

Statement of the Problem

With the long history of tutoring and its questionable affect, not much is known about the kind of people who voluntarily use tutoring regularly. It is unknown whether the feelings students have about the tutors or the tutoring room has any influence on usage. The effect of a tutoring center's appearance on the patronage is unknown. Are students are more likely to seek out touring if they feel the tutor is entirely dedicated to assisting them or if a tutor takes a personal interest in the students' lives? In addition much of the research on tutoring has been in regards to children, rather than college students.

Lecture classes "emphasize learning by listening which may disadvantage students who favor other learning styles" (Schwerdt & Wuppermann, 2011, p. 64). When students learn in a way that accommodates their learning styles, they may be more confident in the subject (Briggs, 2000), enjoy learning more, or learn faster (Graf, Viola, Leo, & Kinshuk, 2007; Popescu, 2010). In a meta-analysis of the literature, Dunn and Griggs (1995) found that accommodating students' learning styles was more effective in mathematics than any other subject and that college students had greater academic gains when accommodated than elementary or secondary school learners (p. 358).

Knowledge of students' learning styles can help teachers explain the material more effectively (Graf, Kinshuk, & Liu, 2009). Martin-Suarez and Alarcon (2010) specifically mentioned that there are "inconsistencies between common learning styles of the engineering students and traditional teaching styles of their professors" (p. 217). If such inconsistencies are found in engineering then there may be similar incompatibility between the way mathematics teachers teach and the way the students learn. Briggs (2000) found that when students understood their own learning styles, they were more confident in their academic ability (p. 22). Lenehan, Dunn, Ingham, Signer, and Murray, (1994) found that students performed better in mathematics when shown how best to study with their individual learning styles. The question arises as to whether the students who seek out tutoring outside of their lecture classes prefer to learn with a person because of a learning style. More specifically, does the strength of learning style result in more or less time spent seeking outside tutoring? Not much is known about the effect of aligning tutoring to learning style or if students desire tutoring due to a learning style.

Little quantifiable research has been done to explain how environment influences student learning, particularly in the tutoring setting. In addition, there is little research as to how important the student perceptions of the tutor and the tutoring environment influence the frequency of use. It may seem logical that students will be more likely to attend tutoring if they have positive feelings about the space and tutor, but whether this is the case, and to what extent it affects the time spent in tutoring is unknown.

Purpose of the Study

The purpose of this quantitative study is to investigate correlations between the number of hours spent in tutoring, the learning styles of undergraduate mathematics students, and the perceptions these students have of their tutoring environments. This study investigated whether students who seek out tutoring have similar learning styles and whether they are different from students who do not seek tutoring. It also investigated associations between learning style and demographics as well an associations between demographics and perceptions of the learning environment.

Research Questions

This study explored the relationship between learning styles and tutoring. There are four guiding questions for this research study.

1. How are learning styles and perceptions of the tutoring environment related to the demographics?
2. How whether students receive mathematics tutoring is related to demographics, learning styles, and perceptions of the tutoring environment?
3. How are hours spent in mathematics tutoring related to learning style and perceptions of the learning environment?
4. What is the difference in hours spent in tutoring among the demographic categories?

Significance of the Study

Informing the administration of post-secondary institutions about the students who use the tutoring recourses may have a significant impact on the institutions. This knowledge may aid these centers in deciding how to spend their resources on training or on changing the physical tutoring space. Tutors may also benefit from knowing the learning styles of their tutees (Briggs, 2000; Lenehan et al., 1994). Knowledge of various learning styles allows tutors to change their explanations to accommodate a wider range of learning styles. Finally students may benefit from knowing their own learning style. Dunn et al. (1989) said, “when permitted to learn difficult academic information or skills through their identified preferences, children tend to achieve statistically higher test and attitude scores than when instruction is dissonant with their preferences” (p. 56).

Theoretical Framework

The theoretical framework of this study will be the Felder-Silverman Learning Style Model (FSLSM). When the FSLSM was first published by Felder and Silverman (1988), their goal was to understand the compatibility of learning styles with teaching styles in engineering educational programs. They defined a learning style model as a way to classify "students according to where they fit on a number of scales pertaining to the way they receive and process information" (p. 684). Felder and Silverman based their model on several other theories which will be addressed as the model is explained. The original model had five components that made up an individual's learning style: perception, input, processing, understanding, and organization, which was later removed from the model. Each component is measured on a bipolar scale. These scales are "continua, not either or categories" (Felder & Spurlin, 2005, p. 104). A learner's preference towards one end of the scale or the other is measured. The learner is classified as having a preference towards one end of the scale or as having no preference towards either end.

The organization component measured whether a student was most comfortable using induction or deduction (Felder & Silverman, 1988). A student most comfortable with induction prefers to be given simple facts and from there to infer a general concept. A student most comfortable with deduction prefers to be given a general principle and then apply it to various applications. Felder found this component difficult to accurately measure and later removed it from the model (Felder, 2002). The current model, which uses the remaining four components, (perception, input, processing, and understanding) will be used as a framework to this study. Figure 1, which is adapted from Felder and Solomon's Index of Learning Styles (p. 6), displays these four components with their polar ends.

PROCESSING

Active												**Reflective**
-11	-9	-7	-5	-3	-1	|	1	3	5	7	9	11

INPUT

Visual												**Verbal**
-11	-9	-7	-5	-3	-1	|	1	3	5	7	9	11

PERCEPTION

Sensory												**Intuitive**
-11	-9	-7	-5	-3	-1	|	1	3	5	7	9	11

UNDERSTANDING

Sequential												**Global**
-11	-9	-7	-5	-3	-1	|	1	3	5	7	9	11

Figure 1. Index of Learning Styles dimensions. From "Index of Learning Styles," by R. M. Felder and B. A. Soloman, p. 6. Copyright 1991 by North Carolina State University. Adapted with permission (See Appendix A).

The *processing* component. Processing refers to "the complex mental processes by which perceived information is converted into knowledge" (Felder & Silverman, 1988, p. 678). In this component learners are categorized as active or reflective learners. Felder and Silverman based this component on Kolb's learning style model. Active experimentation and reflective observation are two of the abilities from which Kolb (1984) believed learning comes. Kolb considered active experimentation as the ability to "use theories to make decisions and solve problems" (p. 30). Reflective observation is the ability "to reflect on and observe [one's] experiences from many perspectives" (p. 30). Kolb pointed out that it is difficult to both reflect and act (experiment) at the same time. Therefore, he put these two abilities on polar ends of each other. Felder and Silverman used the same scale for their learning styles model.

Active learners use experimentation with the information in the external world. This could be discussing the information or testing it in some way. Reflective learners use reflective observation which "involves examining and manipulating the information introspectively" (p. 678). An active learner is "hands on," and does not learn as well in passive learning situations such as lectures. Reflective learners require time to think about the information that is presented rather than the opportunity to interact with it. Active learners work well in groups, while reflective learners work better alone.

The *input* component has to do with the way learners receive information. This is similar to Barbe, Swassing, and Milone's (1979) modality theory (as cited in Filippidis & Tsoukalas, 2009). Felder and Silverman (1988) separated students into visual and verbal learners. Visual learners remember information by viewing it in pictures, graphs, charts, and/or demonstrations. Verbal learners remember best by hearing, reading, and speaking about the information.

The third component in the FSLSM is the *perception* component, which is based on "Jung's theory of psychological types" (Felder & Silverman, 1988, p. 675). Jung (1971) claimed that sensation and intuition are two basic psychological functions. He equated sensation with the perception of a physical stimulus. Sensation is based in bodily senses. Jung defined intuition as that which "mediates perceptions in an unconscious way" (p. 453). With "intuition a concept presents itself whole and complete, without our being able to explain or discover how this content came into existence" (p. 453). Felder and Silverman (1988) used these concepts in developing their conception styles as sensors or intuitors. Sensors prefer to work with facts, do not mind details; they prefer to solve problems with standard algorithms. Intuitors on the other hand prefer to work with theories, are not tolerant of details, and prefer to solve problems by innovative methods. Sensors are "good at memorizing facts" (p. 676), while intuitors are good at understanding new concepts. Intuitors are also more comfortable working with symbols than sensors.

The fourth and final component to the current FSLSM is *understanding* (Felder & Silverman, 1988). Understanding is categorized as sequential or global. Sequential learners must follow a linear thinking process of increasing complexity. On the other hand global learners can jump “directly to more complex and difficult material” (p. 679).

The FSLSM considers learning a two-step process: reception and processing. In the learning process students first receive the information. The perception and input components are included in this step. The students select to perceive information sensory or intuitively, and which senses, visual or verbal, external information is “most effectively perceived” (Felder & Silverman, 1988, p. 675). Next the students process the information. The processing and understanding components are included in this step. The students select to process the information actively or reflectively, and then progress towards understanding sequentially or globally.

The FSLSM does not consider learning style as an unwavering, predictable pattern of behavior. Rather “FSLSM is based on tendencies, indicating that learners with a high preference for certain behavior can also act sometimes differently” (Graf et al., 2007, p. 81). Felder and Spurlin (2005) point out that these preferences can also change depending on one’s experience. Therefore, a student with a strong style for global thinking may switch towards a sequential thinking if they are in a course which relies heavily on linear thought processes.

Overview of Methodology

This study used a quantitative research approach. A correlational methodology was used to investigate the connections between learning style and hours per week spent in tutoring. The participants are traditional undergraduate students enrolled in undergraduate mathematics courses. The sample was taken from two private Hispanic-serving universities in Texas. The tutoring takes place in university-supported mathematics tutoring centers. The instruments used were the Index of Learning Styles (Felder & Soloman, 1991) found in Appendix B and the researcher developed self-reporting survey asking the average hours per week spent in the tutoring center found in Appendix C. In addition, the number of hours spent in tutoring facilities other than the university sponsored tutoring center was reported.

Limitations

This study has several limitations. First, due to privacy issues, the average number of times per week that a student seeks tutoring is self-reported. A second limitation is sample size. The sample comes from only two postsecondary institutions and is limited to the mathematics faculty who allow their class time to be used for the survey. A third limitation is that the tutors all have different mathematical tutoring abilities and only tutor through calculus. These three limitations also mean that the sample will not be a truly random sample of the institutions' math student population. Another limitation is the time the tutors are available. Each tutoring center has set hours and this can limit the time a student can utilize the tutoring center. Whether the hours of operation limited tutoring that took place outside the math labs is unknown. Another significant limitation pointed out by Coffield, Mosely, Hall, and Ecclestone (2004) is that it is difficult to assess the role of learning style in the learning process. Several other factors, such as prior achievement are included in learning. Therefore, results may not be attributable to learning style.

Other limitations are due to the Index of Learning Styles (ILS), the instrument used to measure learning style based on the Felder-Silverman Learning Style Model (FSLSM). The ILS is in English. Therefore any students that are not native English speakers may have difficulty understanding the instrument. Also, the ILS has a forced choice format. Forced choice surveys are designed to force the participant to choose one of a list of options to describe his/her behavior, with no single choice appearing more desirable than the others (Travers, 1951). This formant was developed for rating performance of personnel (Guilford, 1954). Forcing a choice was meant to eliminate bias by asking the rater "not to say whether the ratee has a certain trait or to say how much of a trait the ratee has but to say essentially whether he has more of one trait than another" (p. 274). A significant limitation of forced-choice surveys that pertains to the ILS is that it may force the participant to choose between several responses, none of which may actually apply to the participant (Travers, 1951). For example, the question may ask whether one prefers to read or watch television in their spare time. Some people may prefer to do a third activity not listed. This is particularly a problem when the survey leaves out the neutral response such as "*undecided*, *no opinion*, *uncertain*, or *don't know*" (Friedman & Amoo, 1999, p. 116). If the participants truly do not have preference for one of the choices, they are forced to make a choice at random, which may skew the results.

Another limitation of forced-choice surveys identified by Travers (1951) is that the participant cannot rank one set of items as being more characteristic than another item. For example, a survey may measure the characteristics of communication and teamwork. A forced-choice survey may determine whether participants communicate in writing rather than verbally, and whether they work alone more than with teams. However, the forced-choice survey cannot rate whether communication is more important than teamwork. This limitation is not a concern for the ILS as each dimension measured is considered of equal importance in the FSLSM.

Definition of Terms

Tutoring. Gordon and Gordon (1990) defined tutoring as one-on-one or small group instruction of academic subjects. For this study tutoring will include any out of class individualized instruction.

Learning Style. Several scholars use the term learning style to mean different things. This study will use Sarasin's (1999) definition as a:

> certain specified pattern of behavior and/or performance according to which the individual approaches a learning experience, a way in which the individual takes in new information and develops new skills, and the process by which the individual retains new information or new skills. (p. 1)

Perception. One of the four scales to measure learning style in Felder and Silverman's (1988) model. This refers to the extent a student prefers perceiving information with the senses or with intuition. Sensors are at one end of the scale and intuitors are at the other.

Sensors. Sensors are at one end of the perception scale. Learners are sensors if they are more comfortable perceiving information by external means such as sights, sounds, and activities.

Intuitors. Intuitors are on the opposite side of the perception scale from sensors. Learners are intuitors if they prefer to perceive information internally through insights and hunches. Intuitors are often able to come up with a solution but unable to explain how they came to that solution.

Input. The second of four scales to measure learning style in Felder and Silverman's (1988) model. Input refers to how students prefer to receive information. At one end of the scale are students who prefer visual data and at the other end are learners that prefer verbal data.

Visual. Learners are visual if they are most efficient at taking in visual data such as graphs or pictures.

Verbal. Learners are verbal if they are most efficient at taking in verbal data such as reading material and discussion.

Processing. The third of four scales to measure learning style in Felder and Silverman's (1988) model. Processing refers to how perceived information is converted into knowledge. At one end of the scale learners are active and at the other end learners are reflective.

Active. Active learners are one end of the processing scale in Felder and Silverman's (1988) model. Learners are active if they prefer to process information in activities or discussions.

Reflective. This is the polar opposite of active learners on the Felder and Silverman processing scale. Learners are reflective if they prefers to process information through internal introspection.

Understanding. The fourth of the four scales to measure learning style in Felder and Silverman's (1988) model. Understanding is the way a student progresses towards understanding. One end of the scale is sequential and the other end is global.

Sequential. Sequential learners are on one end of the understanding scale. These learners prefer to learn in sequential steps, leading to understanding.

Global. The polar opposite of sequential learners, these learners prefer to learn in jumps rather than steps. Global learners may also learn holistically rather than sequentially.

Chapter 2: Literature Review

Many issues must be understood for this study. Tutoring was used in education for all of recorded history (Gordon & Gordon, 1990). Evidence suggests that beginning 25 centuries ago in Greece, tutoring was the primary form of education and has continued to be used into modern times. Most institutions of higher education institutions today use some form of tutoring (Rheinheimer et al., 2010, p. 24). This chapter will report the history of how tutoring has been integrated into the western educational systems followed by what the literature states about the effect of tutoring on academic performance. Next will be a description of learning styles, and how the Felder-Silverman Learning Styles Model has been used in previous studies. Then a description of the learning environment and role in learning will be presented.

History of Tutoring

Gordon and Gordon (1990) define tutoring as one-on-one or small group instruction of academic subjects. This teaching began with tutoring oral traditions that were taught to only the select few.

Tutoring in the East. Some of the earliest evidence for tutoring outside of schools comes from China. The civil service exams were instituted by the Sui dynasty (581-618 AD) (Edelman, 1991). These exams were the gateway to employment with the government. Success in the civil service exams were the only way for the lower class to advance socially. The state examinations had “rigorous quotas ensure[ing] that only a tiny fraction [would] pass (Spence, 1996, p. 23). Eventually these exams prompted a national school system to prepare students for the state exams (Edelman, 1991). China financed a national school system 700 years before any country in Europe would do the same. Although China had a national school system, according to Lee (1999) “private classical scholars seemed to be more successful in attracting good disciples," because "private scholars often retreated to scenic sites where they admitted students for private tutoring" (pp. 53-54).

Tutoring in Western Europe. In Greece during the 6th and 7th centuries B.C., most education consisted of tutoring individual members of the upper class. In England from the 15th to the 17th century, the attitude that education should be tailored to the needs of an individual grew. English royalty used tutors to educate their children, as did other families who could afford a private tutor. Enlightenment philosopher, John Locke, thought that private tutoring should be used to educate all children. "Promising young teachers were in such demand as tutors for households, that universities became seriously deprived of them as teachers" (Gordon & Gordon, 1990, p. 101). By the late 17th century private tutors were common in "aristocracy, gentry, and rising mercantile families" (p. 135) in both England and France. Even after schools had been established in the eighteenth century, Western Europe's middle and upper classes still preferred at home education by tutors or governesses.

Tutoring became prevalent in higher education by the middle of the 18th century. English universities used tutor systems in their instructional programs. Oxford and Cambridge used university tutors as the "principal source of instruction" during this period (Gordon & Gordon, 1990, p. 232). Collegiate instruction originally consisted of every student taking the "same subjects at the same time of day in the same room under the same tutor" (Brubacher & Rudy, 1968, p. 83).

Tutoring in the United States. In United States tutoring was the primary source of education in U.S. colonial times and "through the early national period" by families who could afford it (Gordon & Gordon, 1990, p. 275). In rural areas such as the South "families were scattered over such a large geographic area it was impractical to establish grammar schools" (p. 251), so tutoring at home was the only way for children to be educated.

Postsecondary education in the United States began with the founding of Harvard, the first American university (Dvorak, 2001). Harvard had tutors for all students in particular subjects (Gordon & Gordon, 1990). Furthermore, Yale used tutors to instruct individual students outside of professor-run lectures. Lectures during the 18th century were used in part due to the lack of books (Brubacher & Rudy, 1968). Lectures consisted of the professor reading his book to the students who wrote notes on the concepts. Yale students were assigned tutors who they kept throughout their entire program. The best Yale graduates were sought after to stay as tutors to future students (Gordon & Gordon, 1990).

Even at the end of the frontier era around 1890, the increase in population density did not end the use of tutors in the home. Rather, it was the obligatory school attendance laws which slowly made the popularity of tutoring decline as a "socio-educational custom" (Gordon & Gordon, 1990, p. 295). However, tutoring continued to be part of the education system in the 20th century. Many rural schools used peer tutoring as an educational technique. In the 1960s "as public awareness of the tutoring process increased many parents sought private tutorial help for their children" (p. 316), claiming that the schools were not fulfilling the academic needs of their children.

Enrollment in postsecondary institutions more than doubled between 1970 and 2010, and is projected to continue to increase through 2020 (Aud, Hussar, Kena, Bianco, Frohlich, Kemp, . . . & Mallory, 2011). As postsecondary enrollment in the United States increased equal education access programs resulted in a more diverse student population (Rheinheimer et al., 2010). This diversity of students included students who were underprepared. Policy makers and educators designed programs to increase retention of these students. As a result "today, most higher education institutions have some form of academic support programs, most especially tutoring" (p. 24).

A long tradition of tutoring has been documented in western education. In spite of the wide use of tutoring, its effect on academic performance is questionable. The effect tutoring has on students will be the subject of the next section.

Effects of Tutoring

Several studies have investigated the effects of tutoring on academic performance with conflicting results.

Evidence that tutoring has positive effects. Beginning with students in elementary school, Baker et al. (2006) describe an elementary school that recruited tutors from a local university. These tutors were largely made up of elementary education majors. The tutors met with children who were identified as being at risk of failing mathematics. Meetings lasted 90 minutes and occurred once a week. Over the course of a year, at least 72% of students improved in mathematics (p. 289). It is important to note that this study was limited by the lack of a control group. Therefore, it is not possible to conclude that this change in student performance correlated with tutoring.

Menesses and Gresham (2009) had students from 2nd, 3rd, and 4th grades trained in peer tutoring. Peer tutoring took the form of presenting math problems on flash cards and providing correction or praise depending on the tutee's response. These peer tutors were assigned to one of two groups. In the first group, students were paired with one student acting as the tutor and another as the tutee. After a while, the roles would be switched so that each student had experience tutoring and being tutored. The second group of students was also paired but one student was designated to always be the tutor and the other to always be the tutee. Each tutoring session was performed in three minutes and ten cards were presented each session. It was found that using either form of peer tutoring in these math classes "produced a significant increase in math performance" (p. 272).

McDuffie et al. (2009) used peer tutoring in the form of quizzing in ten-minute sessions for seventh grade science students. One student would ask the questions and provide feedback while the other student would respond to the questions. "Results indicate[d] that students in the peer tutoring condition outperformed students in traditional instruction on academic unit tests" (p. 504). Besides academic performance tutoring has also been found to have other effects on students. In McDuffie et al.'s study, students reported enjoying class more when peer tutoring was used.

Topping and Watson (1996) studied secondary students. In their study 12 class hours in an elementary calculus course were substituted with peer tutoring. Peer tutoring was used for 1 hour every other week. The tutoring sessions consisted of one student working out prepared problems for the other student. The student not working was expected to ask questions about the problem being presented. The students would take turns working problems of increasing difficulty and then work together to solve new problems. Topping and Watson found that when this form of peer tutoring was incorporated in an undergraduate calculus course, the passing rate increased to 95% from 71% the previous year when peer tutoring was not used.

Calhoon and Fuchs (2003) initiated two programs in high school mathematics classes. First, the Peer-Assisted Learning Strategies (PALS) program used class-wide peer tutoring to "supplement existing math curriculum" (Calhoon & Fuchs, 2003, p. 236) peer tutoring once again consisted of students pairing up to work together to work on math problems. The second program was Curriculum-Based Measurement (CBM). The CBM is "a well-documented method of tracking and enhancing performance of students with disabilities" (p. 236). The CBM provides ways for teachers to "routinely monitor students' progress toward annual curricular goals" (p. 236). Both PALS and CBM were implemented together in high school mathematics courses for students with disabilities. The program did not produce any significant changes in academic performance, but "students reported that they liked working with a partner" (p. 241), and believed that it made them "work harder in math" (p. 241). Although it was not explained what was meant by "working harder," it seems that working with a tutor may influence the amount of time or effort these students put into math. Similarly, Topping and Watson (1996) found that peer tutoring increased student confidence and engagement in learning mathematics (para. 47).

Tutoring can also benefit teachers. Walker (2007) observed that at a particular high school "most students seemed to have little confidence in mathematics when working individually on problems they needed constant verification of their process and reassurance from their instructors" (p. 59). Tutoring services can help shorten some of the time this verification and reassurance takes as students seek help from other sources (Menesses & Gresham, 2009).

Xu et al. (2001) examined the effects of a voluntary drop-in tutoring service for a college algebra course; students using the service scored lower on the common final exam than students who did not use the tutoring service. However, when taking "math placement level, SAT score, and high school GPA" (para. 10) into account, it was found that tutoring did have a positive effect on final exam score. Furthermore, "attending tutoring made the strongest difference for those students who were at a below average level on the SAT" (para. 10). Hendriksen, Yang, Love, and Hall (2005) also examined college students who sought out tutoring at a learning center and found the majority of tutees believed their grades had improved (p. 61).

Evidence that tutoring has no effect. Although studies such as the ones mentioned above have suggested tutoring improves academic performance, other studies have found that tutoring has no effect on academic performance. Kenny and Faunce (2004) found "coaching intended for secondary school students to improve performance in end-of-year examinations in English, mathematics, or science is generally ineffective" (p. 124). In McDuffie et al.'s study although the tutoring group performed better on unit tests, no difference between the tutoring and non-tutoring groups on cumulative posttests was found. This suggests that tutoring may not have any long-term effects on learning. In addition, Dvorak (2001) found that when college students were tutored over the course of a semester, the tutoring did not foster independent learning (p. 42).

Some scholars believe it is not possible to attribute academic performance to tutoring. Maxwell (1994) states it is difficult to show that students who obtain the most hours of tutoring earn the higher grades because these students who seek out the most tutoring are typically the weakest students. That is, the stronger students may earn the higher grades without tutoring.

Baker et al. (2006) also point out that there are too many variables at work to credit tutoring for academic improvement. For example, while students are receiving tutoring, they are also learning material in the classroom. In addition, most students "have access to and are strongly encouraged to utilize alternate academic support services like instructor office hours, academic counseling, and learning support workshops" (Xu et al., 2001, para. 7). Therefore, it is impossible to credit any academic improvement to tutoring alone.

Tutoring may not have any effect on academic performance, yet the demand for tutoring remains. The difficulty of the material may have nothing to do with desire for tutoring. Lee (2007) found that classroom instruction had no effect on the demand for tutoring. Furthermore, Powers and Rock (1999) found that students who seek tutoring tend to be high academic achievers, so their academic ability may have already been high before tutoring. Powers and Rock's study conflicts with Maxwell's (1994) study which claimed that weak students were the ones using tutoring. The results from Powers and Rock (1999) imply that students seeking tutoring are not necessarily the students who have the most difficulty with the material, but there may be something about tutoring that they enjoy. These students may have learning styles in common, which will be addressed in the next section.

Learning Styles

The way an individual learns is influenced by several factors, particularly how a learner "interacts with and responds to the learning environment" (Popescu, 2010, p. 243). Sarasin (1999) defines a learning style as a:

> certain specified pattern of behavior and/or performance according to which the individual approaches a learning experience, a way in which the individual takes in new information and develops new skills, and the process by which the individual retains new information or new skills. (p. 1)

Exploring learning styles. Dunn et al. (1989) believed that some characteristics which make up a student's learning style are biological (such as sensitivity to temperature), while others develop over time (such as motivation to complete learning tasks). Personality contributes significantly to learning style (Sarasin, 1999). An outgoing person "may need interaction with others to process information adequately enough to apply it, while more reserved student may learn better away from other students" (p. 34).

Each learning style is unique to the individual; hence, a great diversity of learning styles exist (Sarasin, 1999). Correlational studies done with children have found that learning style differs among students of the same age or grade; of similar achievements, interests, or talents; and even differs within families (Dunn et al., 1989). This diversity increases as students age (Sarasin, 1999). By adulthood students have typically "developed and adapted in unique ways throughout their years" (p. 3) of education. As a result, adults are usually more comfortable with their way to learn and may have more difficulty adapting to a variety of teaching strategies than younger learners. This can lead to frustration, and resignation to failure in the adult learner. Therefore, Sarasin asserts that it can be particularly beneficial for teachers of postsecondary institutions to understand basic learning styles.

It is important to note that there is a difference between learning style and learning flexibility (Pashler, McDaniel, Rohrer, & Bjork, 2008). That is, students may learn better if information is presented in written format rather than orally, but that does not mean they are unable to learn from orally presented information. Therefore, even if postsecondary educators do not accommodate particular learning styles, it does not mean that the students cannot master the material.

It is also important to note that a common misconception is to equate learning style with intelligence (Gardner, 1999). Howard Gardner, who developed the theory of multiple intelligences, defined intelligence as "the ability to solve problems or to create products that are valued within one or more cultural settings" (p. 33). Later he redefined it as "a biopsychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture" (p. 33-34).

Although understanding intelligences can help one understand the process of learning, the multiple intelligence theory is not a learning style (Sarasin, 1999). However, Garner (1999) explains that a learning style is an approach that a learner uses to a wide range of content, while intelligence is the capacity for a specific content. For example, if a person's learning style has an auditory trait, then they typically learn best from hearing information. This student has the potential to learn mathematics or languages by hearing the information. Therefore, the student approaches two different intelligences with the same learning style.

Popescu (2010) reported that there has been a great interest in learning styles over the past 30 years. According to Briggs (2000), in the past the obligation for understanding the material had been with the learner. That is, the students were responsible for adapting to each teacher's teaching style. However, there has been a slow shift towards the obligation being with the educators to be more aware and adaptive to the learning styles of individual students.

Learning styles' influence on education. Some scholars claim that adapting to a student's learning style increases academic performance. Al-Balhan (2007, p. 47) found that among middle school children in Kuwait, students performed better when teachers addressed learning styles. Dunn, Sklar, Beaudry, and Bruno (1990) found that minority college students performed better in mathematics when taught in accordance with a particular learning style (p. 287). Lenehan et al., (1994) tutored freshmen/transfer nursing students how to best study in accordance with their individual learning styles. These students performed better than the students in the control group (pp. 463-464). Sarasin (1999) explained that one reason for increased performance is because one's learning style includes the "amount of stimuli a person can accept and still learn. . . . Learning will increase if the outside stimuli matches the amount that a certain learning style requires or can accept" (p. 34).

In addition to possible improved performance, evidence suggests that accommodating styles may have other benefits. Unlike Al-Balhan (2007), Briggs (2000) studied the effects of learning style on British college students. Briggs found that when students understood their own learning style they were more confident in their academic ability (p. 22). Other reported benefits of learning style accommodation include increased efficiency of time needed for studying, enjoyment, better motivation (Popescu, 2010), reduced anxiety while learning (Lenehan et al., 1994), and less difficulty in learning (Graf et al., 2009; Popescu, 2010). Some studies also suggest that students learn faster when their styles are accommodated (Graf et al., 2007, p. 126; Popescu, 2010, p. 251).

Many people do not understand what learning styles are and what they are not. Pashler et al. (2008) cautioned parents not to credit their children's failure to learn on the institution's approach. He affirmed that learning styles have nothing to do with ability. In addition, some scholars who claim the benefits of accommodating learning style listed above are questionable. Pashler et al. found no evidence to "provide adequate support for learning-style assessments in school settings" (p. 116). Coffield et al. (2004) mentioned that several factors contribute to the learning process. Therefore, assessing the role that learning styles take is problematic; hence, it is difficult to attribute increased performance and speed of learning to accommodation to style.

Learning style models. A major criticism of learning style theory is that there is no universally accepted learning style model (Popescu, 2010). Rather, a great number of learning style models exist, many of which have overlapping components. Coffield et al. (2004) examined 71 such models and admitted that this did not include all the models in the literature. Coffield et al. classified these 71 models into five families: constitutionally based, cognitive structures, stable personality type, learning approaches/strategies of learning, and flexibly stable learning preferences.

Constitutionally based learning style models assume that styles are fixed or at least extremely difficult to change (Coffield et al., 2004). Cognitive based models consider styles as a basis for behavior towards learning. These models assume that "cognitive styles are deeply embedded in personality structure" (p. 36). Consequently, learning style models in the cognitive based family link the way people think to personality features. The stable personality trait family is interested in what makes up a stable personality type. Theorists using such models believe that learning style is "one part of the observable expression of a relatively stable personality type" (p. 46). Learning approaches/strategies of learning family of models considers an individual's way of learning to be an approach or strategy which takes previous experience and context into account. Theorists working under this family use the terms "learning strategy" or "learning approach" rather than learning style. They do this to distance themselves from previous ideas of learning styles. The flexibly stable learning preferences are based on the idea that "a learning style is not a fixed trait, but a differential preference for learning, which changes slightly from situation to situation" (p. 60). Even though learners' styles can change between situations, the changes they make are stable. Felder-Silverman's Learning Styles Model (FSLSM) falls under this model of learning style, and will be discussed in the next section.

Felder-Silverman Learning Style Model. Coffield et al. (2004) categorized the FSLSM as a flexibly stable learning preference. That is the FSLSM does not consider learning style fixed, but rather as preferences that change depending on the situation (Felder & Spurlin, 2005).

The FSLSM has four components: perception, input, processing, and understanding (Felder & Silverman, 1988). These components will be measured with the Index of Learning Styles (ILS) (Felder & Spurlin, 2005). The ILS has been established as reliable and valid when administered to college students and older individuals (Felder & Spurlin, 2005). Graf et al. (2007) claimed, "the ILS is an often used and well investigated instrument to identify learning styles" (p. 83). Furthermore, the FSLSM and ILS have been used in other educational studies (Filippidis & Tsoukalas, 2009; Graf et al. 2009; Marin-Suarez & Alarcon, 2010). Filippidis and Tsoukalas (2009) used the ILS to find the learning styles of students, then had their adaptive educational system present more detailed versions of the course to sequential learners, and less detailed to global learners. Over 70% of students in their pilot study found their adaptive educational system helpful when it tailored their sequential/global learning styles (p. 148). Graf et al. (2009) used the FSLSM's classifications as basis for their tool, Detecting Learning Styles (DeLeS), for detecting learning styles. Rather than testing students' direction Graf et al.'s tool determines learning style through analysis of student behavior observed by teachers. The researchers had students take the ILS and had them analyzed with the DeLeS. They found the results from the DeLeS were accurate over 73% of the time (p. 9). Marin-Suarez and Alarcon (2010) used the FSLSM to classify physics students to better understand if learning style influences the conceptual learning of physics. The results indicated that students were mostly verbal and global learners (p. 220).

There has been, and continues to be, an interest in understanding learning styles in education. Although some studies have shown evidence that students learn more effectively when taught in a way that accommodates their styles, others studies have found contradictory evidence. A plethora of models are used to categorize students into different learning styles. No one model is considered the standard in education.

Learning Environment

Much has been written about learning environments of the classroom (Bosch, 2006; Dale, 1972; Emmer & Evertson, 2009; Simmons, 2002; Verduin, Miller, & Greer, 1977). Less has been written about the learning environment of tutoring. Much of the information about learning environments is in the form of experts suggesting the best way to create the learning environment and not how students perceive their learning environments. According to Beer and Darkenwald (1989) “the perceptions and reactions of students to their educative experiences are especially salient” (p. 34).

The literature on learning environments is divided into two parts: the physical space, and the interactions among the students/instructors. In regards to the physical learning space, Emmer and Evertson (2009) suggested arranging students’ positions so they face away from “potential sources of distraction such as windows, the doorway . . . or eye-catching displays” (p. 5). People are exposed to “an enormous amount of incoming stimuli” (Gall, Gall, Jacobsen, & Bullock, 1990, p. 16). It is impossible to address all of the stimuli, so it is important to reduce the external stimuli in the learning environment. Dale (1972) pointed out that “learning involves a creative interaction between the stimulus and the individuals response” (p. 16), so the environment with which the learner interacts with must be taken into account.

Another aspect of minimizing distractions is background noise. Cassidy and Macdonald (2007) found that cognitive task performance was worse while background noise or music was present than in silence. There is some quantitative support for a proper learning environment.

Reese and Dunn (2008) found that high school students with the lowest grade point averages had a preference for "music or conversation while concentrating" (p. 105).

Besides minimizing distractions the classroom should be arranged so that students can "see all of the significant instructional tools, such as the chalkboard" (Simmons, 2002, p. 162) and the instructors have all necessary materials within reach. Bosch (2006) made the additional suggestion that the physical environment should minimize distractions but should also "make students enjoy coming to class" (p. 7). This includes making the room "bright and welcoming" (p. 7) and adjusting the temperature to a comfortable setting. In their study, Reese and Dunn (2008) found that students with the higher grade point averages had a preference for studying with bright light. The comfort of the room should also be taken into consideration in students' studying environments. Lenier and Maker (1980) recommended studying at a "well lighted desk in a room relatively free from noise and interruptions" (p. 9).

The second aspect of a learning environment has to do with the way students feel about interacting in the class or tutoring room. Kuh, Kinzie, Schuh, Whitt, and Associates (2005) point out the importance of student perceptions of the environment; they stated that students must perceive their institutional environments as "inclusive and affirming" (p. 8), where expectations are clear. The way a person feels can have a large effect on learning (Dale, 1972); hence students need to "feel emotionally secure and valued as persons" (Bosch, 2006, p. 45). This includes encouraging participation and making students feel safe about making mistakes.

Marland and Rogers (1997) suggested that the tutor room should be set up for social support between students. The tutoring room is where students get help, and should be a space where students feel comfortable asking for and giving help to each other. Rabow et al. (1999) recommended that tutors show enthusiasm and empathy for their tutees as well as patience, and interact with them "on as equal a level as possible" (p. 25). This builds an attitude of acceptance and trust for the learners. One of the practical obligations a tutor has in creating a trustful learning environment is to show up consistently and on time.

Whether it has to do with the physical learning space or the way the learners interact with others, there is no shortage of advice offered on building a learning environment. It is recommended that the setting should minimize distractions and that the learners need to feel safe and confident in their interactions within the learning environment.

Summary

Tutoring has been a form of instruction for many centuries (Gordon & Gordon, 1990). The effect tutoring has on modern education is unclear. The effect of learning styles on education is also debatable (Baker et al., 2006; Calhoon & Fuchs, 2003; Maxwell, 1994; McDuffie et al., 2009; Topping & Watson, 1996). Some believe that understanding and accommodating learning styles makes learning easier and more efficient (Al-Balhan, 2007; Briggs, 2000), while others criticize learning theory for lack of a universal model (Popescu, 2010) or believe the role of learning styles in the learning process is not understood (Coffield et al., 2004; Pashler et al., 2008). The learning environment also may have some impact on the learner (Bosch, 2006; Dale, 1972; Emmer & Evertson, 2009; Simmons, 2002; Verduin et al., 1977). The environment set up in a way that minimizes distractions and allows bright light is suggested, as is a supportive interaction with the instructors. The types of learners are affected, and the extent to which the environment affects them is unknown. The way tutoring, learning styles, and learning environment all interact to affect an individual is unclear.

Chapter 3: Methodology

The current study is a quantitative study to investigate correlations between number of hours spent in tutoring and learning styles of undergraduate mathematics students.

Research Design

A correlational design was used. According to Creswell (2008) correlational designs use statistical tests to "describe and measure the degree of association (or relationship) between two or more variables" (p. 356). Correlational designs should be used when the purpose is to "relate two or more variables to see if they influence each other" (p. 356). Since this study was meant to investigate the relationship between learning styles and average number of hours spent per week in tutoring, a correlation design fits.

Setting

The tutoring centers of interest are "math labs" affiliated with a university. Both "Math Labs" are located in the same building as the mathematics faculty offices. No appointments are needed to use either lab. Students can come during any of the 40 hours per week the lab is open to receive help. All services are free. The mathematics faculty does not require any student to spend any amount of time in the lab; using the lab is entirely voluntary. Also, no limitations are made as to how many hours a student may use the lab.

The type of tutoring offered in both labs is primarily homework based. Students ask about particular problems rather than asking tutors to explain an entire concept. However, some conceptual tutoring is often performed in the course of aiding students with problems. Most of the tutoring is done by other undergraduate students with advanced mathematics experience, supervised by a graduate mathematics student who also participates in some of the tutoring.

Participants

The participants from both locations were undergraduate students enrolled in a mathematics class at the time of the study. The students were enrolled in traditional lecture style mathematics courses at one of the two private liberal arts universities in Texas. Participants were selected from developmental math, college algebra, precalculus, and calculus courses at these institutions. These were traditional, semester-long undergraduate courses (as opposed to online or rapid-pace courses). The selection process was dependent upon the instructor of each course. The process began with seeking permission from the mathematics instructors to allow their students to participate in the study. Each interested instructor's classes were used in the study. The reason for including all students in these classes is to investigate if any learning styles which are common to students who seek out tutoring are also common to those who do not seek tutoring.

Instruments

A correlational study uses two sets of variable scores (Creswell, 2008). The results may indicate an association but do not prove an association. In this study the first variable was the average number of hours per week a student voluntarily attends a school tutoring lab. This variable was measured with a self-reported survey. In addition, the participant answered several questions regarding his/her perception of the tutoring environment. A copy of this researcher-designed survey is in Appendix C. Also included in this survey are 12 questions regarding the participants' feelings about the tutoring environment. These questions are answered with a four-point Likert scale. Demographic information is also included in this researcher-designed survey. This information includes age, gender, and whether the participant is a native English speaker. Finally, the college classification of freshmen, sophomore, junior, and senior will be asked. This classification is determined by the number of completed college course hours. Freshmen have completed 0 to 29 hours, Sophomores 30 to 59, Juniors 60 to 89, and Seniors 90 or more.

The second set of variables will be the categories of learning style. The instrument used was the Index of Learning Styles (ILS) developed to measure the four components of learning style from the Felder and Silverman Learning Styles Model (FSLSM) (Felder & Soloman, 1991), reprinted by permission of North Carolina State University, and is in accordance with permission to use the ILS for educational research. The ILS is made up of 44 questions (Felder & Spurlin, 2005). The ILS has 11 questions assigned to measure style for each learning style component (perception, input, processing, and understanding). Each component is a continuous scale between to bipolar opposite styles. Perception ranges from sensory to intuitive, input from visual to verbal, processing from active to reflective, and understanding from sequential to global. Each question in the ILS has two possible responses, at opposite ends of the corresponding continuum. The subject is forced to pick one of these answers. When all questions for a particular component are scored an odd number between 1 and 11 is obtained, as is a direction towards one of the polar ends of the component. This was coded as an odd number from -11 to 11; 11 being the strongest preference towards one pole of the component, and -11 being the strongest preference towards the other. Each score is associated with a moderate preference towards one polar end, strong preference to one polar end, or no preference. For example, a question measuring perception would have one answer associated with a sensory style and another with an intuitive style. When all four questions about perception are scored the learner could be assessed to have a strong sensory style, a strong intuitive style, a moderate sensory style, a moderate intuitive style, or no perception style.

Protection of Human Participants

In order to protect the human rights' of the participants, the researcher obtained approval from the University of the Incarnate Word Institutional Review Board (IRB), and the IRBs from participating institutions. The participants were informed that participation is purely voluntary. Those who participated signed a consent form before the surveys were administered. A copy of this consent form is in Appendix D. The consent form includes information about the purpose of the study, the role the participants will play, and how much time their participation will require. In addition, the form also states that the participants have the right to remove themselves from the study. At the time the consent form was distributed, participants were able to ask questions to clarify their understanding of the study. Participants were assured that the decision to participate or not would not in any way affect their course grade, their relationship with their university. Complete anonymity was maintained. No names were on the data collected, and participants cannot be identified from the demographic information collected. If this study is published, only group data will be used. This study did not involve any physical risk or expense to the participants.

Data Analysis

The data was coded and analyzed using the Statistical Package for the Social Sciences (SPSS). The independent variables were: Age, Gender, Course, College Classification, Perception, Input, Processing, and Understanding, and Perceptions of the Learning Environment. Age is a scale variable. Gender is a categorical variable with values of male or female. Course identifies the math course the participant is currently enrolled in; Course is an ordinal variable with values of developmental, algebra, precalculus, or calculus. College classification is an ordinal variable from freshmen to senior. Perception, Input, Processing, and Understanding are all ordinal variables with values of odd numbers between -11 and 11. The dependent variables were the dichotomous variable of whether the student sought tutoring, and the scale variable of average number of hours per week the student spent receiving math tutoring. If a student reported an interval of time for average number of hours per week spent in tutoring the average was coded into SPSS. For example if a student reported spending 2 to 5 hours in tutoring per week, then 3.5 hours was coded into SPSS as their hours per week.

First, a principal component analysis was performed on the data from the Tutoring Information and Demographics Survey. Once the variables within the environment survey were identified they were treated as independent variables. Two way associations between variables were checked. This provided information about how the variables interact with each other. An independent sample t-test or their non-parametric equivalents was run to see if each independent variable has an effect on the average hours per week.

In order to investigate the correlation between tutoring hours and learning styles several questions must be addressed. Most of the guiding research questions have specific sub-questions which are answered in Chapter 4.

1. How are learning styles related to demographics?
2. How is use of mathematics tutoring related to learning styles and demographics?
    a. How are learning styles related to whether students receive tutoring?
    b. How are the demographics related whether students receive tutoring?
3. How are hours spent in mathematics tutoring related to learning style and perceptions of the learning environment?
    a. How is the number of hours spent in mathematics tutoring related to the way students prefer to process new information?

b. How is the number of hours spent in mathematics tutoring related to the way students prefer to take in new information?
c. How is the number of hours spent in mathematics tutoring related to the way students prefer to perceive new information?
d. How is the number of hours spent in mathematics tutoring related to the way students prefer to build understanding new information?
e. How is the number of hours spent in mathematics tutoring related to the way students perceive the learning environment?

4. What is the difference in hours spent in tutoring among the demographic categories?

Chapter 4: Results

The purpose of this study was to investigate correlations between the number of hours spent in tutoring, the learning styles of undergraduate mathematics students, and the perceptions these students have of their tutoring environments. This chapter will begin with a descriptive analysis of the data collected. Then an investigation into associations among the variables will be presented. Finally, the analysis for each research question will each be discussed.

Descriptives

A total of 834 undergraduate mathematics students were surveyed; 400 from one university, and 434 from another. The frequencies of the students who submitted valid data for each of the variables will be addressed. These variables include the use of tutoring, demographics, learning style, and perceptions of the learning environment.

Demographics. Out of the 834 students surveyed, 709 reported their ages. Ages ranged from 18 to 58 with 75.56% of them either 18 or 19. Table 1 shows the frequencies of the demographic variables other than age. There were slightly more females than males. Most of the students surveyed came from courses below the calculus level. Over half the students surveyed were freshmen. A little over a fourth of the students were non-native English speakers. The typical student was 18, native English speaking, female, freshmen, non-calculus student.

Use of tutoring services. The frequency of students who reported using mathematics tutoring either in the math lab at their university or outside the math lab can be seen in Table 2. Overall fewer students used tutoring than did not. Less than a third of the students reported using tutoring in the math lab, and less than a fourth of the students reported using tutoring outside the math lab. Of those who received tutoring, over two thirds used the math lab, almost half were tutored outside the math lab, and less than a fourth were tutored both in and out of the math lab.

Table 1

Frequencies of Demographic Information

	Frequency	Percent of Participants
Age		
18	342	48.2
19	193	27.2
20	64	9.0
21	42	5.9
Over 21	68	9.6
Total	709	99.9
Male	358	43.1
Female	473	56.9
Total	831	100.0
Freshmen	563	67.7
Sophomore	159	19.1
Junior	85	10.2
Senior	16	1.9
Other	8	1.0
Total	820	100.0
Developmental	225	27.0
Algebra	294	35.3
Precalculus	237	28.4
Calculus	78	9.4
Total	834	100.0
Native English Speaker	614	73.6
Non-Native English Speaker	220	26.4
Total	834	100.0

Note. Some totals do not add to 834 due to missing data and some percentages do not add to 100 due to rounding.

Table 3 displays the frequencies of students who sought tutoring only during the week of a test. Around one third of the students who were tutored in the math lab were only tutored during the exam week. Similarly, around one third of the students who were tutored outside the math lab were only tutored during exam week. This indicates that the majority of students are not just using tutoring to study for exams.

Table 2

Frequencies of Students use of Tutoring Services

	Frequency	Percent of Participants	Percent of Those Tutored
Used any math tutoring service	366	43.9	100
Did not use any math tutoring service	460	55.2	
Total	826	99.0	
Tutored in the math lab	248	29.7	67.8
Not Tutored in the math lab	578	69.3	
Total	826	99.0	
Tutored outside of the math lab	178	21.3	48.6
Not Tutored outside of the math lab	642	77.0	
Total	820	98.3	
Tutored both in and out of the math lab	60	7.2	16.4

Note. Some frequency totals do not add to 834 due to missing data, some percentages of participants may not add to totals due to rounding, and some percent of those tutored may not add to 100 because of students who are tutored both in and outside of the math lab.

For the students sought tutoring other than test week the average hours per week spent in tutoring ranged from less than one hour to 12 hours. For the students who were only tutored during exam week, the hours on exam week they reported in tutoring ranged from less than one hour to 14 hours (see Figure 2, Outliers of 12 and 14 hours were removed for this boxplot.). There was one case that reported spending 60 hours in tutoring each week. This case was considered an extreme outlier and removed for most of analysis.

Table 3

Frequencies of Students who Were Only Tutored During Test Week

Only Tutored During Test Week	Frequency	Percent Tutored in the Math Lab	Percent Tutored Outside the Math Lab
Used the math lab	85	34.3	0.0
Tutored outside the math lab	59	0.0	33.1
Tutored both in and out of the math	6	2.4	3.4

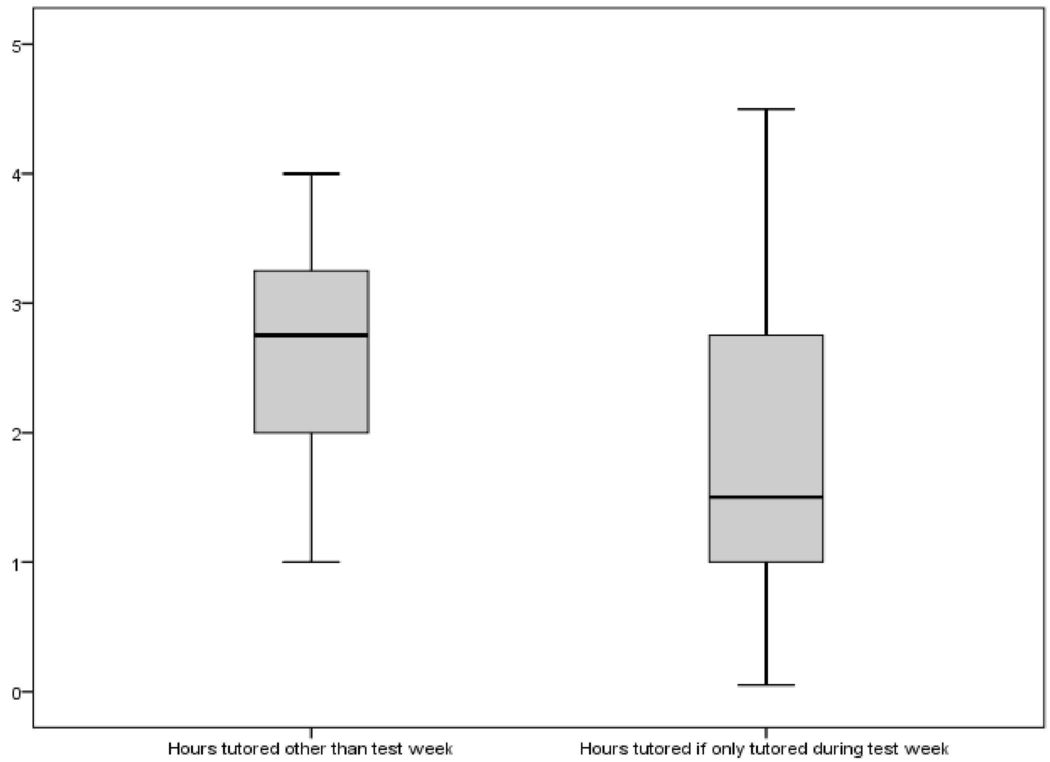

Figure 2. Boxplot of average hours per week tutored during test week and other than test week.

Table 4 shows the frequencies of students from each gender, course, college classification, and language classification who sought mathematics tutoring in and out of the math lab. The data indicates that a higher percentage of males sought tutoring in the math lab, but a higher percentage of female sought tutoring outside the math lab. The percentage of males who used tutoring services outside the math lab was much lower than that percentage of males who were tutored in the math lab.

The percentage of students in each course who used the math lab increased as each course level increased. Only 13.5% of developmental students surveyed were tutored in the math lab, but over half the calculus students reported using the math lab. Most of the students who reported using tutoring services were freshmen, but a lower percentage of freshmen reported using tutoring than any other college classification.

The percentage of native and non-native English speakers who used the math lab were very close. This indicates that the native language does not have a big impact on whether a student uses the math lab. However, a smaller percentage of non-native English speakers received tutoring outside the tutoring lab.

Learning style. Although all of the participants filled out parts of the Index of Learning Styles (ILS), some participants left questions blank. Cases with missing data from one of the components of the ILS were excluded from the analysis as Zywno (2003) did in his validation study of the ILS. The number of cases this left with complete ILS component scores can be seen in Table 5. Scores for Processing, Input, Perception, and Understanding were calculated according to the ILS instructions.

Processing. Processing scores had a skew value of .1 with a standard error of .09, which produced a z score of 1.11. Sheskin (2007) states that this should be within the range of -3 to 3 in order to be assumed not skew. Since the z score is within the acceptable range from -3 to 3 the data can be assumed to not be skewed. The kurtosis value was -.51 with a standard error of .17, which produced a z score of -3. Since this is on the boarder of the acceptable range, the data is not assumed kurtotic. A view of the histogram (Figure 3) for processing score show that they are approximately normal. The processing scores were used to categorize each case in accordance with the ILS: a processing score of, -11 to -9 is strong active preference, -7 to -5 is moderate active preference, -3 to 3 is balanced processing, 5 to 7 is moderate reflective preference, and 9 to 11 is strong reflective preference. These five categories the frequencies can be seen in Table 6. The majority of students had a balanced processing learning style.

Table 4

Frequencies of Students who Received Mathematics Tutoring by Demographics

	Total	Received Tutoring in the Math Lab	Received Tutoring Outside the Math Lab
Male	358	122	68
Female	473	126	110
Developmental	225	30	36
Algebra	294	77	73
Precalculus	237	98	43
Calculus	78	43	26
Freshmen	563	127	99
Sophomores	159	68	48
Juniors	58	43	25
Seniors	16	7	6
Other	8	1	0
Native English Speaker	614	168	136
Non-native English Speaker	220	80	42

Table 5

Frequency of Learning Style Scores Without Missing Data

	Processing	Input	Perception	Understanding
n	788	787	789	801

Table 6

Frequencies of Processing Categories (Active to Reflective)

	Frequency	Percent of Participants Without Missing Data in the Processing Category
Strong Active	48	6.1
Moderate Active	176	22.3
Balanced Processing	456	57.9
Moderate Reflective	97	12.3
Strong Reflective	11	1.4
Total	788	100.0

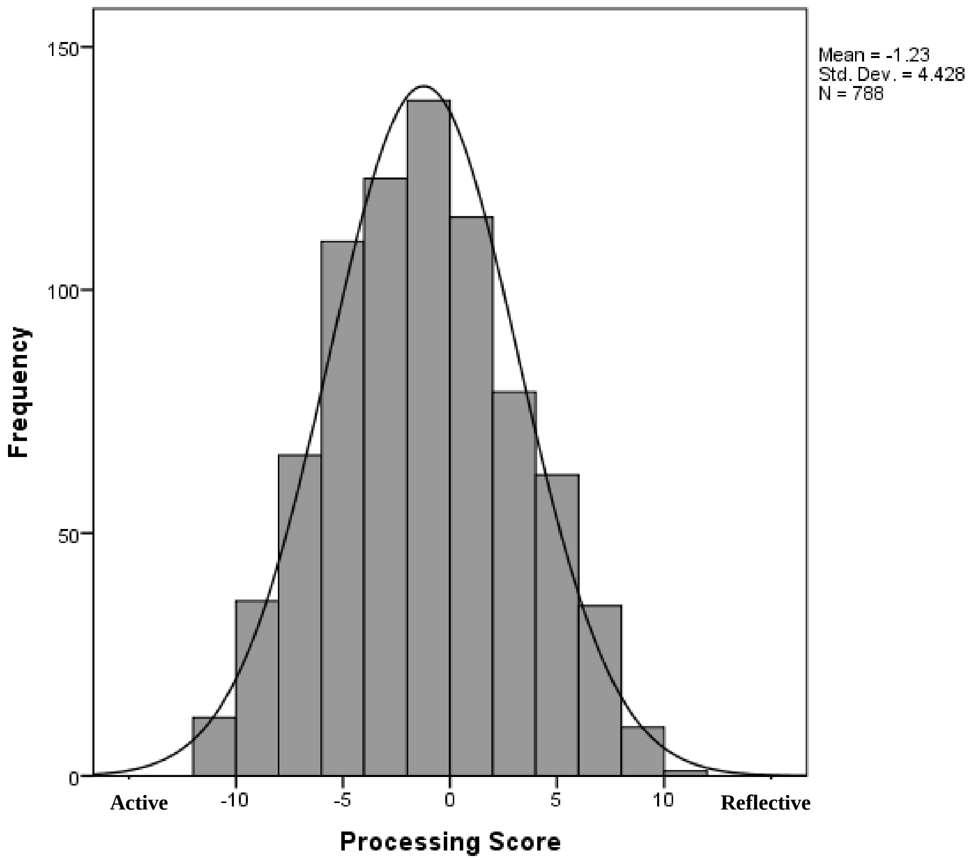

Figure 3. Histogram of processing scores.

Input. Input scores had a skew value of .45 with a standard error of .09, which yields a z score of 5. This is outside the acceptable range so the data is assumed skewed. The kurtosis value is -.326 with a standard error of .174, which produces a z score of -1.873. Since this is within the acceptable range, the data is assumed not kurtotic. The histogram for input (Figure 4) shows a skew towards visual learners. Using the input score to categorize each case in accordance with the ILS: an input score of, -11 to -9 is strong visual preference, -7 to -5 is moderate visual preference, -3 to 3 is balanced input, 5 to 7 is moderate verbal preference, and 9 to 11 is strong verbal preference. The frequencies of these categories can be seen in Table 7. Most students were visual preference or balanced.

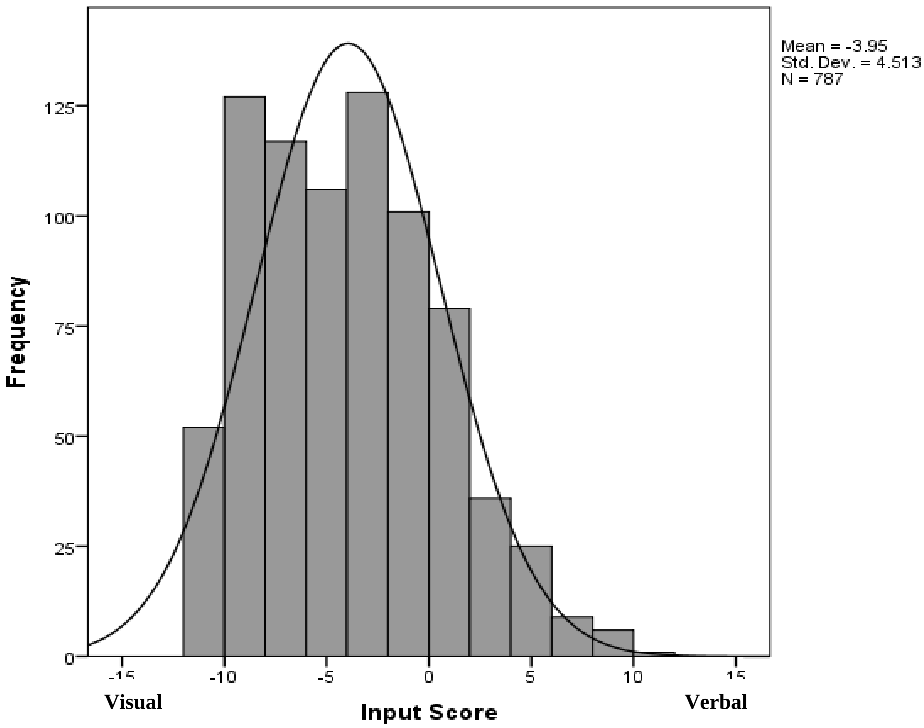

Figure 4. Histogram of input scores.

Table 7
Frequencies of Input Categories (Visual to Verbal)

	Frequency	Percent of Participants Without Missing Data in the Input Category
Strong Visual	179	22.7
Moderate Visual	223	28.3
Balanced Input	344	43.7
Moderate Verbal	34	4.3
Strong Verbal	7	0.9
Total	788	100.0

Note. Totals of percentages are not 100 for every characteristic because of rounding.

Perception. The perception scores had a skew value of .47 with a standard error of .09, which yields a z score of 5.22 which is outside the acceptable range. The kurtosis value was -.4 with a standard error of .17 which produces a z score of -2.36, which is within the acceptable range. The histogram (Figure 5) shows that they are approximately normal, although the skew towards sensory perceptions can be seen in the histogram. The perception score was used to categorize each case in accordance with the ILS: a perception score of, -11 to -9 is strong sensing preference, -7 to -5 is moderate sensing preference, -3 to 3 is balanced perception, 5 to 7 is moderate intuitive preference, and 9 to 11 is strong intuitive preference. The frequencies of these categories can be seen in Table 8. The majority of students had a sensing or balanced perception preference.

Table 8

Frequencies of Perception Categories (Sensory to Intuitive)

	Frequency	Percent of Participants Without Missing Data in the Perception Category
Strong Sensing	88	11.2
Moderate Sensing	231	29.3
Balanced Perception	362	45.9
Moderate Intuitive	85	10.8
Strong Intuitive	23	2.9
Total	788	100.0

Note. Totals of percentages are not 100 for every characteristic because of rounding.

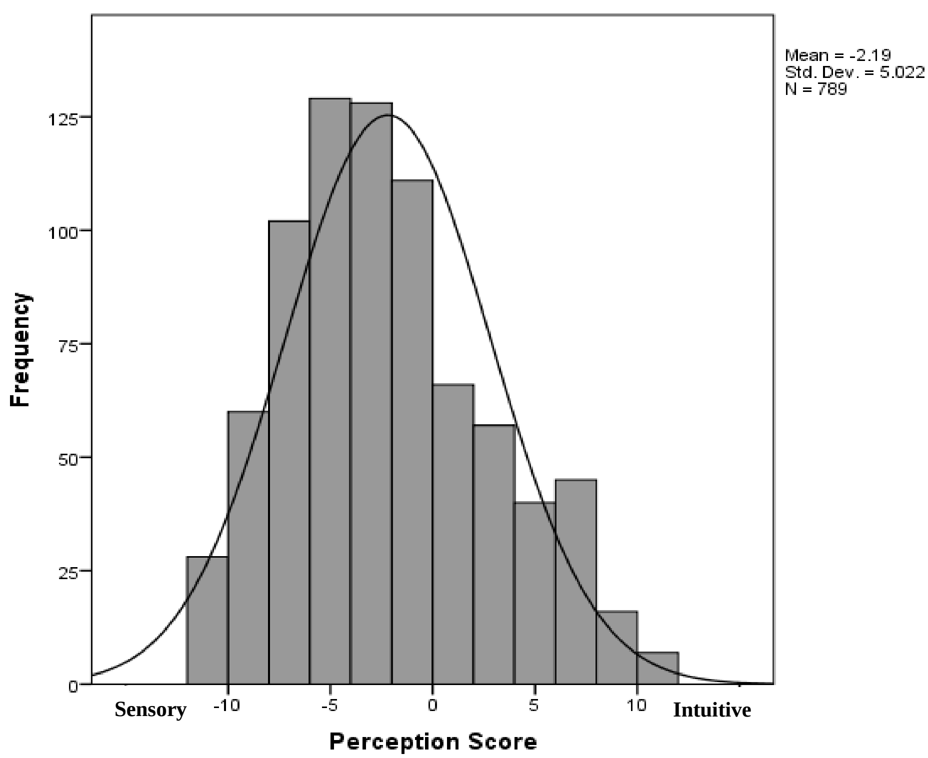

Figure 5. Histogram of perception scores.

Understanding. The understanding scores had a skew value of .33 with a standard error of .09, producing a z score of 3.67, outside the acceptable range. The kurtosis value was -.23 with a standard error of .17 yielding a z score of -1.35, which is within the acceptable range. The skew of the data towards sequential preference can be seen in the histogram in Figure 6. Using the understating score to categorize each case in accordance with the ILS: an understanding score of, -11 to -9 is strong sequential preference, -7 to -5 is moderate sequential preference, -3 to 3 is balanced understanding, 5 to 7 is moderate global preference, and 9 to 11 is strong global preference. The frequencies of these categories can be seen in Table 9. The majority of students had a sequential to balanced understanding preference.

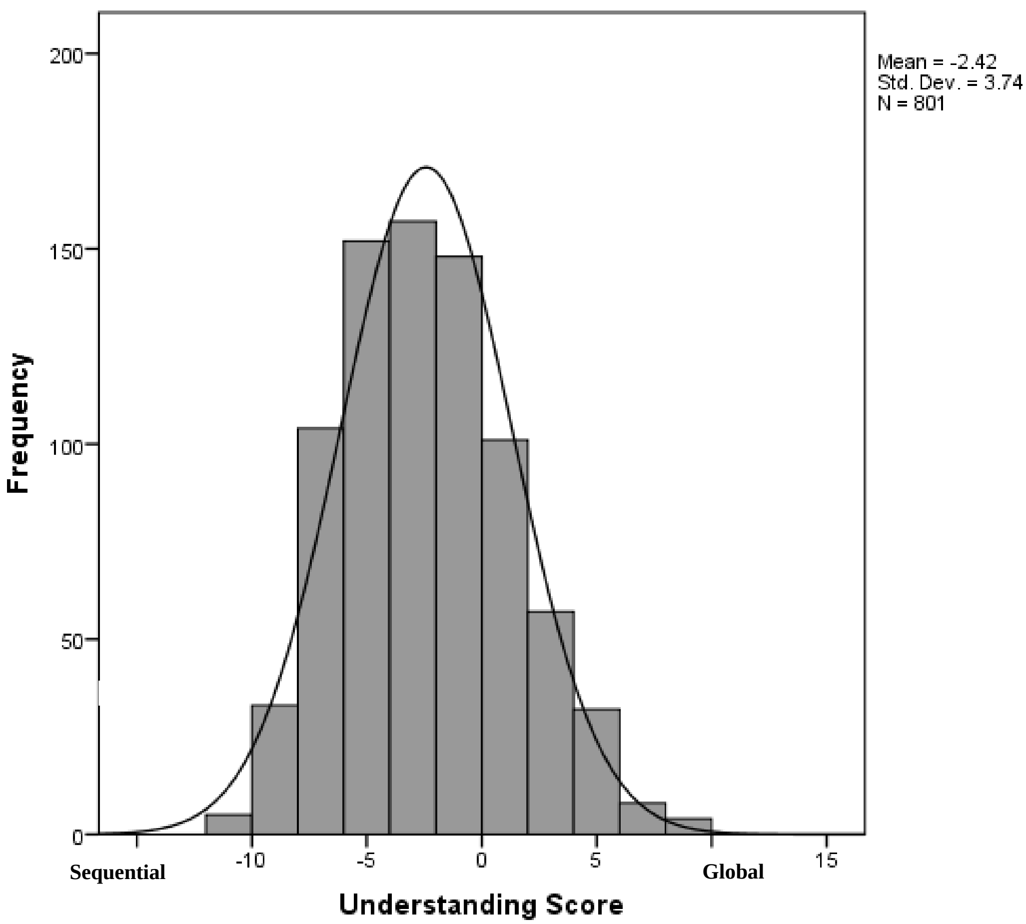

Figure 6. Histogram of understanding scores.

Table 9

Frequencies of Understanding Categories (Sequential to Global)

	Frequency	Percent of Participants Without Missing Data in the Understanding Category
Strong Sequential	39	4.9
Moderate Sequential	254	31.7
Balanced Understanding	464	57.9
Moderate Global	40	5.0
Strong Global	4	0.5
Total	801	100.0

Perceptions of the tutoring environment. Of the 12 questions from the Tutoring Information and Demographics Survey regarding student perceptions of the tutoring environment, three factors were assumed. Items 1 through 6 asked about the tutor, items 7 and 8 asked about distractions, and items 9 through 12 asked about tutoring space. A principle component analysis was use to analyze each factor separately. If the factor analysis obtained a one-component solution then there is support for the assumption that each factor measures a single construct.

The Cronbach's alpha coefficient method was also conducted to measure internal reliability within factors. According to George and Mallery (2003) a Cronbach's alpha greater than .7 indicates internal consistency. The results from the principle component analysis and Cronbach's alpha are summarized in Table 10. The factors of tutor perceptions, and space perceptions had alpha values greater than .7 which suggest internal consistency, and factor loadings ranging from .63 to .80, and no improvement in alpha with any items deleted. Therefore the average of these responses will be used to measure tutor perceptions and space perceptions. However the alpha value for distraction is below .7, and therefore item 7 (how often the tutee gets distracted) and 8 (how often the tutor gets distracted) will be used separately in the analysis.

Table 10

Principle Component Analysis for the Perceptions of the Tutoring Environment

Factor	KMO	Eigenvalue	% of Variance	Item	Factor Loading	Alpha
Tutor Perceptions	.84	3.15	52.56	1	.72	.82
				2	.63	
				3	.76	
				4	.68	
				5	.74	
				6	.80	
Space Perceptions	.72	2.29	57.21	9	.67	.75
				10	.70	
				11	.80	
				12	.84	
Distraction	.50	1.30		7	.82	.52
				8	.82	

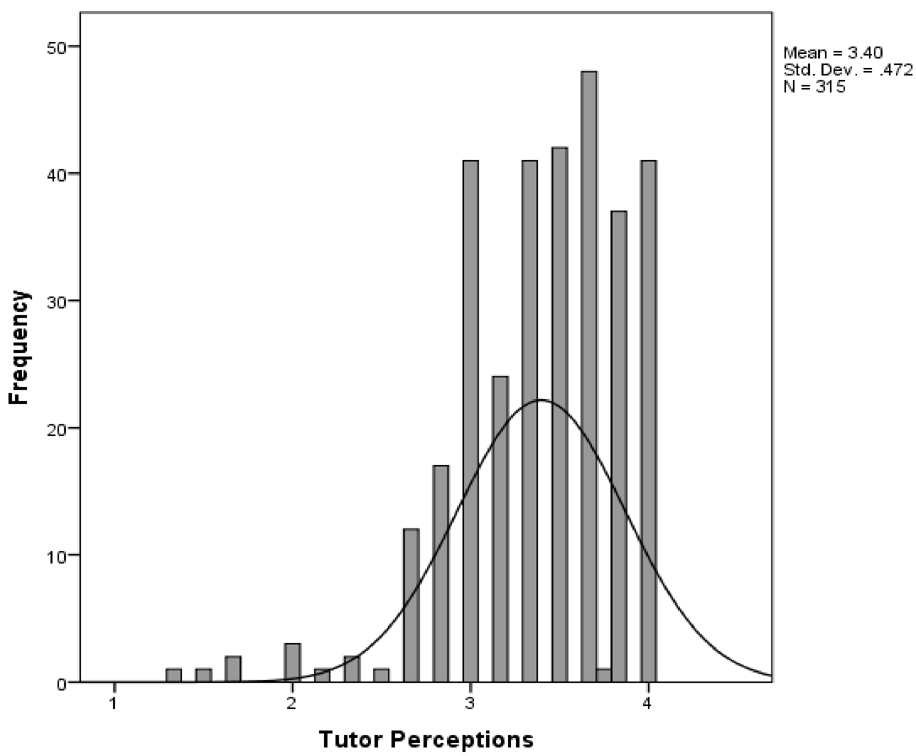

Figure 7. Histogram of perception of tutor scores.

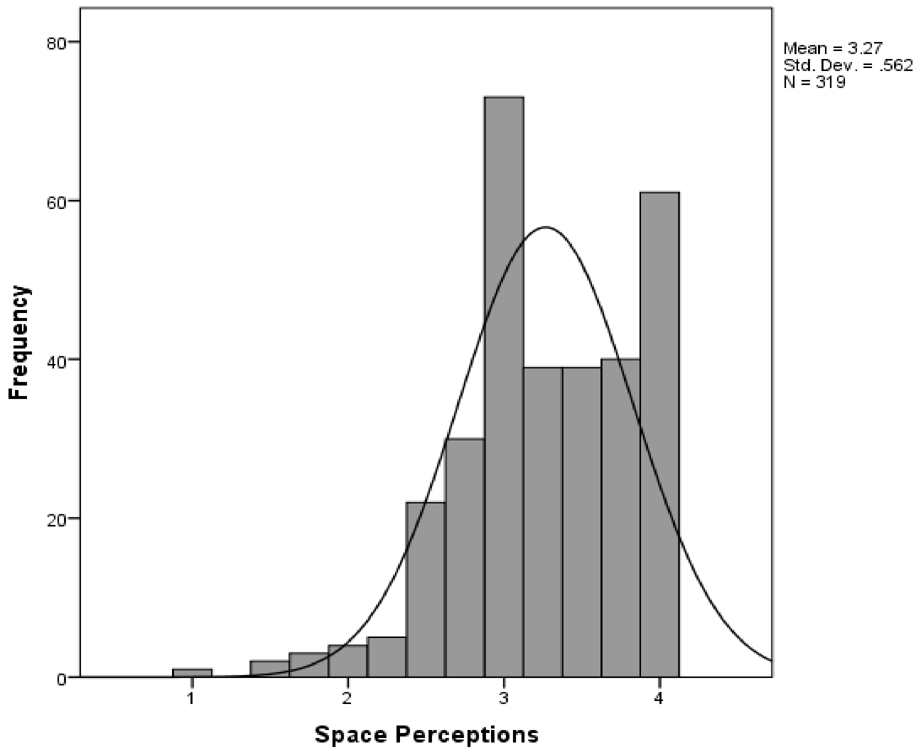

Figure 8. Histogram of perception of space scores.

Research Questions

The research questions address four types of variables: use of tutoring, demographic information, learning styles, and perceptions of the tutoring environment. Research questions one, two, and three are answered using chi-square and Kendall's tau tests of association. The fourth research question is answered using non-parametric Mann-Whitney U tests, and Kruskal-Wallis tests.

Research question 1. How are learning styles related to demographics?

Demographic variables were gender (male or female), course (developmental, algebra, precalculus, or calculus), college classification (freshmen, sophomore, junior, senior, or other), and whether English was their first language. Learning style consisted of the four ordinal component scores: processing, perception, input, and understanding.

Chi-squared tests of association will indicate a relationship between categorical data (Sheskin, 2007). Gender and native English speaking status were categorical, and the learning style variables were ordinal. The chi-squares indicate a relationship between learning style and gender or native English speaker, but the order of the learning style score was not taken into account (Sheskin, 2007). According to Norušis (2008) there should be “no more than 20%” (p. 17) of expected cell counts are less than 5. If the expected cell counts less than 5 then the results are not reliable. Tables 11-14 show the crosstab frequencies for learning style and demographic variables and summarize the results. No significant associations were found. The results indicate that no relationship can be assumed between gender and learning style, or between whether students are native English speakers and learning style.

According to Norušis (2008) Kendall’s Tau-C test should be used to measure association between two ordinal variables. Since the learning style variables and demographic variables course and college classification are ordinal, Kendall’s Tau-C measures were used to test for correlations. Several significant associations were found; the results are summarized in Tables 11-14. The first correlation was between processing preference and the course the student is enrolled in. The majority of students in developmental and algebra were moderate active to balanced in their perception. Precalculus and calculus students were balanced to moderate reflective. The perception appears to have become less active as the level of the course increased.

Next a relationship was found between input score and college classification. All of the college classifications tended to have a strong to moderate visual input preference. Another significant correlation was found between perception and course. Developmental and algebra students tended to be low sensory to balanced, precalculus and calculus have more students with higher sensory scores.

Table 11

Crosstab Frequencies of Processing Score and Demographic Variables

		Processing Score												
		Active										Reflective		
		-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Total
Gender	Male	6	15	33	43	47	67	55	27	19	14	5	0	331
	Female	6	21	33	67	76	71	59	52	43	20	5	1	454
Total		12	36	66	110	123	138	114	79	62	34	10	1	785
$\chi^2(11) = 13.65$, $p = .25$, % expected cell count less than 5 = 12.5%														
Course	Developmental	3	14	17	33	30	40	21	25	15	10	1	1	210
	Algebra	4	12	28	46	47	45	38	22	18	9	5	0	274
	Precal	4	5	16	25	37	43	39	22	20	12	3	0	226
	Cal	1	5	5	6	9	11	17	10	9	4	1	0	78
Total		12	36	66	110	123	139	115	79	62	35	10	1	788
$\tau = .08$, $p = .00$														
College Classification	Freshmen	8	27	42	79	80	90	69	56	47	22	6	1	527
	Sophomore	3	6	16	16	23	25	27	16	10	7	2	0	151
	Junior	1	3	6	12	17	16	15	5	2	5	1	0	83
	Senior	0	0	1	3	2	5	4	0	0	1	0	0	16
	Other	0	0	1	0	1	2	0	1	3	0	0	0	8
Total		12	36	66	110	123	138	115	78	62	35	9	1	785
$\tau = .002$, $p = .94$														
Native English Speaker	Yes	9	29	52	75	93	108	85	58	46	25	9	0	589
	No	3	7	14	35	30	31	30	21	16	10	1	1	199
Total		12	36	66	110	123	139	115	79	62	35	10	1	788
$\chi^2(11) = 8.4$, $p = .63$, % expected cell count less than 5 = 16.7%														

Note. Totals do not add to 834 due to missing data.

Table 12

Crosstab Frequencies of Input Score and Demographic Variables

		Input Score												
		Visual										Verbal		
		-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Total
Gender	Male	26	64	53	47	51	40	30	12	8	1	1	0	333
	Female	26	63	62	59	77	61	49	24	17	8	5	1	452
Total		12	52	127	115	106	128	101	79	36	25	9	6	1
$\chi^2(11) = 14.94$, $p = .25$, % expected cell count less than 5 = 20.8%														
Course	Developmental	9	31	42	28	32	27	18	11	4	4	2	0	208
	Algebra	18	43	43	30	41	33	34	13	14	2	2	0	273
	Precal	19	43	26	30	43	28	20	9	6	3	2	0	229
	Cal	6	10	6	18	12	13	7	3	1	0	0	1	77
Total		12	52	127	117	106	128	101	79	36	25	9	6	1
τ = -.02, p =.57														
College Classification	Freshmen	29	72	86	67	88	69	61	28	18	8	5	0	531
	Sophomore	14	31	17	21	20	23	14	1	4	1	1	1	148
	Junior	8	16	10	16	16	8	2	4	2	0	0	0	82
	Senior	1	4	2	2	2	0	2	2	0	0	0	0	15
	Other	0	3	1	0	2	0	0	1	1	0	0	0	8
Total		12	52	126	116	106	128	100	79	36	25	9	6	1
τ = .-08, p =.00														
Native English Speaker	Yes	40	99	95	76	92	77	52	22	19	6	5	1	584
	No	12	28	22	30	36	24	27	14	6	3	1	0	203
Total		12	52	127	117	106	128	101	79	36	25	9	6	1
$\chi^2(11) = 12.09$, $p = .36$, % expected cell count less than 5 = 20.8%														

Note. Totals do not add to 834 due to missing data.

Table 13

Crosstab Frequencies of Perception Score and Demographic Variables

		Perception Score												
		Sensory										Intuitive		
		-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Total
Gender	Male	12	25	45	63	54	41	30	18	22	17	6	2	335
	Female	16	34	56	66	74	70	36	39	17	28	10	5	451
Total		12	28	59	101	129	128	111	66	57	39	45	16	7
$\chi^2(11) = 10.93$, $p = .45$, % expected cell count less than 5 = 8.3%														
Course	Developmental	7	15	25	38	30	27	24	18	12	8	5	3	212
	Algebra	11	17	26	51	40	46	21	23	14	19	4	2	274
	Precal	4	20	40	27	43	31	14	11	10	17	7	2	226
	Cal	6	8	11	13	15	7	7	5	4	1	0	0	77
Total		12	28	60	102	129	128	111	66	57	40	45	16	7
$\tau = -.06$, $p = .046$														
College Classification	Freshmen	13	37	73	81	79	77	49	42	32	32	14	2	531
	Sophomore	11	15	18	29	26	21	11	8	3	6	1	2	151
	Junior	2	5	9	13	18	11	5	5	4	5	1	3	81
	Senior	0	2	0	4	4	1	0	1	1	2	0	0	15
	Other	2	1	2	0	0	1	1	1	0	0	0	0	8
Total		12	28	60	102	127	127	111	66	57	40	45	16	7
$\tau = -.05$, $p = .03$														
Native English Speaker	Yes	24	41	69	89	98	92	46	43	32	34	12	6	586
	No	4	19	33	40	30	19	20	14	8	11	4	1	203
Total		12	28	60	102	129	128	111	66	57	40	45	16	7
$\chi^2(11) = 13.88$, $p = .24$, % expected cell count less than 5 = 8.3%														

Note. Totals do not add to 834 due to missing data.

Table 14

Crosstab Frequencies of Understanding Score and Demographic Variables

		Understanding Score												
		Sequential										Global		
		-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Total
Gender	Male	3	12	31	68	69	63	42	26	18	4	4	0	340
	Female	2	21	73	83	87	84	59	31	14	4	0	0	458
Total		5	33	104	151	156	147	101	57	32	8	4	0	798

$\chi^2(10) = 16.9$, $p = .08$, % expected cell count less than 5 = 27.3%

		-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Total
Course	Developmental	1	9	31	41	43	34	26	17	9	2	0	0	213
	Algebra	0	11	46	54	51	52	33	19	12	3	2	0	283
	Precal	4	9	16	46	50	47	30	17	5	3	1	0	228
	Cal	0	4	11	11	13	15	12	4	6	0	1	0	77
Total		5	33	104	152	157	148	101	57	32	8	4	0	801

$\tau = .04$, $p =.24$

		-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Total
College Classification	Freshmen	3	22	63	107	104	98	70	40	23	7	3	0	540
	Sophomore	1	8	22	23	33	29	19	10	4	0	1	0	150
	Junior	0	2	14	19	13	17	9	7	2	1	0	0	84
	Senior	1	1	4	2	4	2	1	0	1	0	0	0	16
	Other	0	0	0	0	2	2	2	0	2	0	0	0	8
Total		5	33	103	151	156	148	101	57	32	8	4	0	798

$\tau = -.03$, $p =.02$

		-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Total
Native English Speaker	Yes	2	27	76	107	113	116	76	46	23	6	3	0	2
	No	3	6	28	45	44	32	25	11	9	2	1	0	3
Total		5	33	104	152	157	148	101	57	32	8	4	0	801

$\chi^2(10) = 8.4$, $p = .58$, % expected cell count less than 5 = 22.7%

Note. Totals do not add to 834 due to missing data.

Perception also had a significant correlation with college classification. Freshmen, sophomores, juniors, and seniors tended to be moderate sensory to balanced, while students classified as other were strong sensory preference. Finally there was a correlation between understanding and college classification. Freshmen, sophomores and students classified as other tended to be moderate sequential to balanced, while juniors and seniors had more students with higher sequential preferences.

Research question 2. How is use of mathematics tutoring related to learning styles and demographics?

How are learning styles related to whether students receive tutoring? Since whether students received tutoring was a categorical variable, and learning style was ordinal, chi-squared tests of association will indicate a relationship between variables, but not take the order of learning style score into account (Sheskin, 2007). Once again, results are only reliable if all expected values in the crosstabs tables that are less than 5 are no more than 20% (Norušis, 2008).

Processing. The processing score is measured from active to reflective. After eliminating the cases with missing processing values, the relationship between processing and whether a student receives tutoring was investigated. Table 15 shows the crosstab frequencies of processing and whether students received tutoring. The results from the chi-square tests can be seen in Table 16; no significant correlations were found. Therefore no relationship can be assumed between the way the students preferred to processes information and whether the student used tutoring.

Input. The input score measures how students prefer to take in new information, and is measured from visual to verbal. Visual learners prefer to take in information with pictures and graphs while verbal learners prefer to take in information with written or spoken words. After eliminating the cases with missing input values the relationship between input and whether a student receives tutoring was investigated using chi-squared measures. Table 17 shows the crosstab frequencies of input and whether students received tutoring. Table 18 summarizes these results. The expected cell count less than 5 was over 20% for all three chi-squared measures. Therefore the results are not reliable (Norušis, 2008). Consequently no relationship can be assumed between how the students preferred to take in new information and whether they received tutoring.

Table 15

Crosstab Frequencies of Processing and Whether Tutoring Was Received

		Processing Score												
		Active									Reflective			
		-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Total
Received Tutoring	Yes	6	14	36	44	57	54	56	32	23	13	3	0	338
	No	6	22	30	66	66	85	59	47	39	22	7	1	450
	Total	12	36	66	110	123	138	114	79	62	34	10	1	788
Tutored in the Math Lab	Yes	6	7	27	28	35	36	38	22	16	10	2	0	227
	No	6	29	38	82	87	101	74	57	45	25	8	1	553
	Total	12	36	65	110	122	137	112	79	61	35	10	1	780
Tutored Outside the Math Lab	Yes	2	9	15	24	29	28	29	15	9	5	1	0	166
	No	10	27	50	85	88	109	84	64	53	29	9	1	609
	Total	12	36	65	109	117	137	113	79	62	34	10	1	775

Note. Totals do not add to 834 due to missing data.

Table 16

Chi-Square Values Between Processing and Whether Students Seek Tutoring

	% expected cell count less than 5	χ^2	*df*	*n*	*P*
Sought any tutoring	12.5	10.60	11	788	.48
Used the math lab	16.7	12.67	11	780	.32
Used tutoring outside the math lab	16.7	6.63	11	775	.83

Table 17

Crosstab Frequencies of Input and Whether Tutoring Was Received

		Input Score												
		Visual										Verbal		
		-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Total
Received Tutoring	Yes	25	53	53	55	61	51	38	16	11	2	1	0	366
	No	36	81	76	55	73	53	45	20	16	7	5	1	468
	Total	61	134	129	110	134	104	83	36	27	9	6	1	834
Tutored in the Math Lab	Yes	15	32	34	32	45	35	22	10	9	2	0	0	236
	No	37	95	83	70	82	65	57	25	16	7	5	1	543
	Total	52	127	117	102	127	100	79	35	25	9	5	1	779
Tutored Outside the Math Lab	Yes	11	27	22	30	24	21	18	7	3	0	1	0	164
	No	41	98	95	72	101	78	61	28	21	9	5	1	610
	Total	52	125	117	102	125	99	79	35	24	9	6	1	774

Note. Totals do not add to 834 due to missing data.

Table 18

Chi-Square Values Between Input and Whether Students Seek Tutoring

	% expected cell count less than 5	χ^2	*df*	*n*	*p*
Sought any tutoring	20.8	10.13	11	787	.52
Used the math lab	20.8	7.94	11	779	.72
Used tutoring outside the math lab	20.8	8.84	11	774	.64

Perception. The perception score measures how students prefer to perceive new information and is measured from sensory to intuitive. Sensors prefer to perceive information through observations, and intuitions prefer to perceive information through insights and hunches. After eliminating the cases with missing perception values the relationship between perception and whether a student receives tutoring was investigated. Table 19 shows the crosstab frequencies between perception and whether students receive tutoring. The results from the chi-square tests can be seen in Table 20. No correlation was found between perception and whether students use tutoring services. Therefore no relationship can be assumed between how students preferred to perceive information and whether they used tutoring.

Table 19

Crosstab Frequencies of Perception and Whether Tutoring Was Received

		Perception Score												
		Sensory									Intuitive			
		-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Total
Received Tutoring	Yes	12	23	49	56	61	50	27	20	17	20	4	4	343
	No	16	37	53	73	67	61	39	37	23	25	12	3	446
	Total	28	60	102	129	128	111	66	57	40	45	16	7	789
Tutored in the Math Lab	Yes	10	17	37	38	41	36	17	11	11	11	1	3	233
	No	17	43	65	89	87	74	47	44	29	34	15	4	548
	Total	27	60	102	127	128	110	64	55	40	45	16	7	781
Tutored Outside the Math Lab	Yes	4	11	19	27	34	21	13	13	7	13	3	2	167
	No	24	47	82	102	91	89	51	44	32	31	13	5	611
	Total	28	58	101	129	125	110	64	57	39	44	16	7	778

Note. Totals do not add to 834 due to missing data.

Table 20

Chi-Square Values Between Perception and Whether Students Seek Tutoring

	% expected cell count less than 5	χ^2	*df*	*n*	*p*
Sought any tutoring	8.3	7.13	11	789	.79
Used the math lab	12.5	11.91	11	781	.37
Used tutoring outside the math lab	8.3	6.70	11	778	.82

Understanding. The final relationship between learning style and use of tutoring which was investigated was between understanding and use of tutoring. The understanding score measures how students prefer to build understanding new information, and is measured from sequential to global. Sequential learners prefer to learn in small steps leading to a big picture, while global learners prefer to move directly to the larger concept. After eliminating the cases with missing understanding values the relationship between understanding and whether a student receives tutoring was investigated. Table 21 shows the crosstab frequencies between the understanding score and whether a student uses tutoring. The results from the chi-square tests are summarized in Table 22. The expected cell count less than 5 is more than 20% for each chi-squared test, so no relationships between understanding and use of tutoring can be assumed (Norušis, 2008).

Table 21

Crosstab Frequencies of Understanding and Whether Tutoring Was Received

		Understanding Score												
		Sequential									Global			
		-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Total
Received Tutoring	Yes	4	14	43	61	66	79	36	25	15	6	2	0	351
	No	1	19	61	91	91	69	65	32	17	2	2	0	450
	Total	5	33	104	152	157	148	101	57	32	8	4	0	801
Tutored in the Math Lab	Yes	4	8	27	41	49	56	24	13	9	4	2	0	237
	No	1	25	76	110	108	90	76	43	22	3	2	0	556
	Total	5	33	103	151	157	146	100	56	31	7	4	0	793
Tutored Outside the Math Lab	Yes	0	9	24	25	29	39	16	15	8	2	1	0	168
	No	5	23	80	124	125	106	85	40	24	6	2	0	620
	Total	5	32	104	149	154	145	101	55	32	8	3	0	788

Note. Totals do not add to 834 due to missing data.

Table 22

Chi-Square Values Between Understanding and Whether Students Seek Tutoring

	% expected cell count less than 5	χ^2	*df*	*n*	*p*
Sought tutoring	27.3	15.56	10	801	.11
Used the math lab	27.3	18.93	10	793	.04
Used tutoring outside the math lab	22.7	11.07	10	788	.35

How are the demographics related whether students receive tutoring? The demographic variables were Age, Gender, Course, College Classification, and native English speaker. Over 5% of the cases had Age 18 or 19. This was not a large enough variety to look for any differences in tutoring in terms of age.

*Gender***.** The frequencies of students who receive tutoring separated by gender are displayed in Table 23. Since both gender and whether students use tutoring were both categorical, the relationship between them was investigated using Chi-squared tests of association (Sheskin, 2007). The results can be seen in Table 24. The only significant association was found between gender and whether a student uses the math lab. Sheskin (2007) states that a Cramér's V can be used to measure the effect size of an association. Cohen (1988) states that a Cramér's V of .1 indicates a weak association, .3 a weak association and .5 indicates a large association. A Cramér's V=.08 was calculated, which indicates a weak association using Cohen's guidelines. There is evidence that gender had a weak influence on whether a student used the math lab, but made no difference in whether a student was tutored outside the math lab. Over half the students who reported using the lab were female. However a higher percentage of males reported using the lab than females. Therefore even though females made up the majority of the students tutored in the lab, males were more likely to seek tutoring in the lab.

Table 23

Crosstabs Frequencies of Gender and Tutoring Use

Tutoring status	Male	% of males	Female	% of females
Tutored anywhere	162	45.3	204	43.1
Not tutored anywhere	196	54.7	269	56.9
Total	358	100.0	473	100.0
Tutored in the math lab	122	34.5	126	6.9
Not Tutored in the math lab	232	65.5	343	73.1
Total	354	100.0	469	100.0
Not tutored outside math lab	68	19.4	110	23.6
Tutored outside of math lab	282	80.6	357	76.4
Total	350	100.0	467	100.0

Note. Totals do not add to 834 due to missing data.

Table 24

Chi-Square Values Between Gender and Whether Students Seek Tutoring

	χ^2	*df*	*n*	*p*	*Cramér's V*
Sought any tutoring	.37	1	831	.54	-
Used the math lab	5.53	1	823	.02	.08
Used tutoring outside the math lab	2.00	1	817	.16	-

Note. The expected cell count less than 5 is 0% for all χ^2.

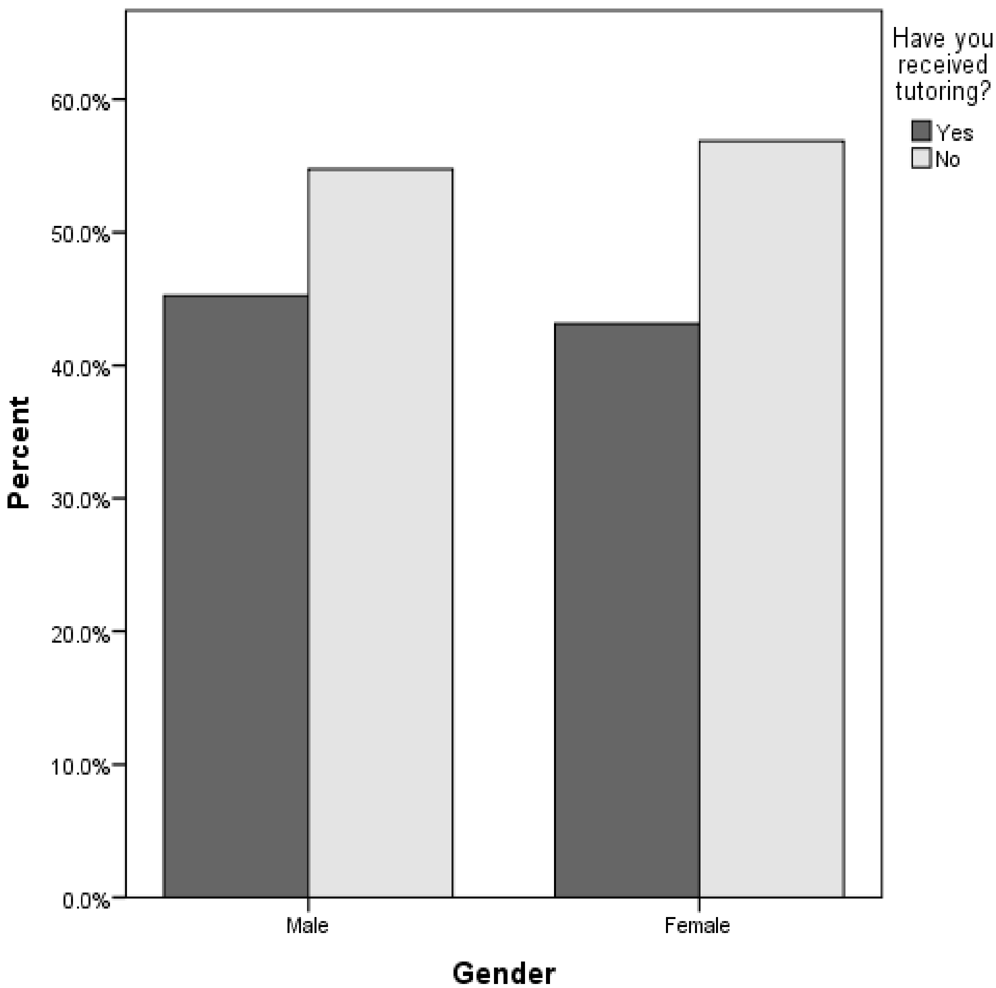

Figure 9. Bar graph of gender compared to use of tutoring.

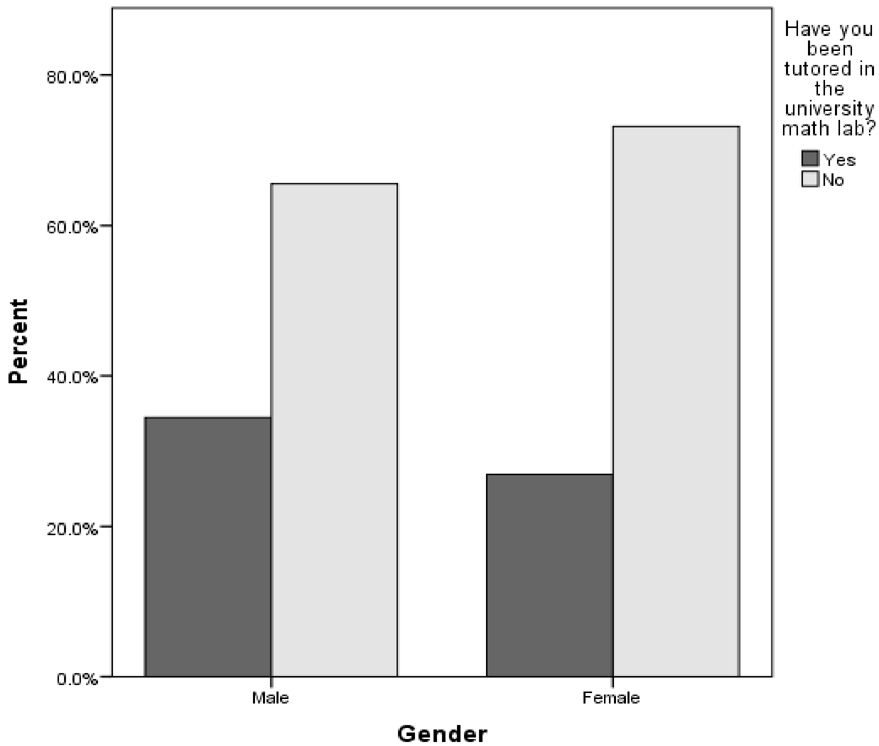

Figure 10. Bar graph of gender compared to use of the math lab.

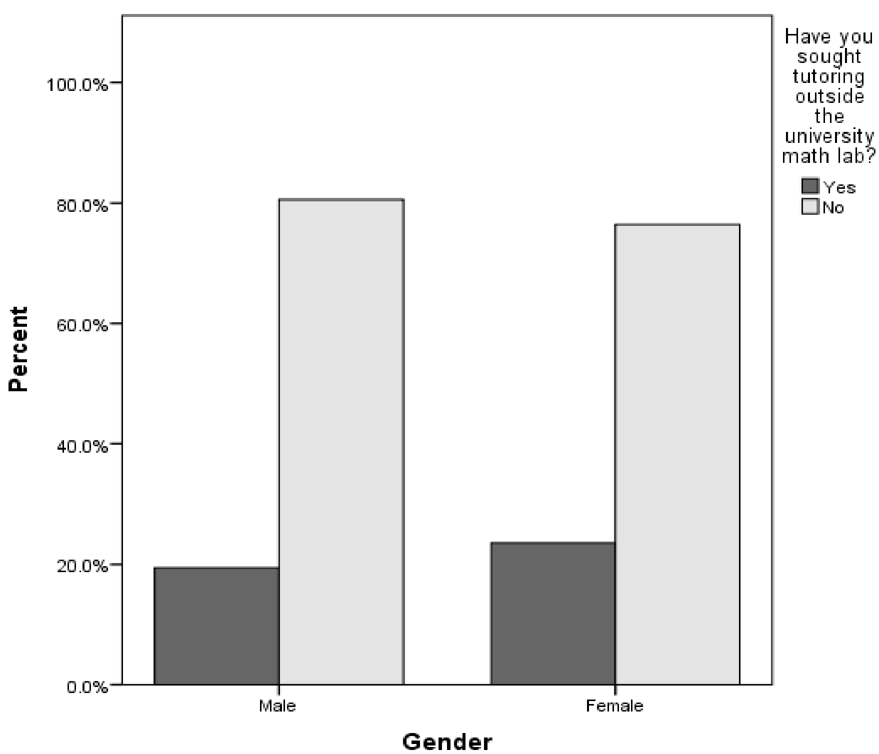

Figure 11. Bar graph of gender compared to use of tutoring outside the math lab.

Course. Table 25 shows the frequencies of students who receive tutoring separated by course. Since course and whether students receive tutoring were categorical variables, the relationship between course and whether a student receives tutoring was investigated using chi-squared tests of association (Sheskin, 2007). The results can be seen in Table 26. Three significant associations were found. The first association found was between the course that the student is enrolled in and whether the student uses tutoring. A Cramér's V=.25 indicated this to be a weak to moderate association (Cohen, 1988). The likelihood of using tutoring increased with the course level. Just over a fourth of developmental students used tutoring, less than half of algebra students, around half of precalculus students, and over two thirds of calculus. However the majority of students who have received tutoring are algebra and precalculus students. Therefore even though most of the students who are tutored are algebra and precalculus students, calculus students are the most likely to seek out tutoring.

A Cramér's V=.29 indicated a moderate association between course and whether the student uses that math lab. As with the previous association, the likelihood of using the math lab increased with the level of the math course the student is enrolled in. A Cramér's V=.14 indicated a weak association between course and whether the student is tutored outside the math lab. Unlike the using the math lab, the likelihood of using tutoring outside the math lab increased, decreased, then increased again as the level of math course increases. These results indicate that the course the student was enrolled in was related to whether the student used tutoring services in the math lab, outside the math lab, or both.

Table 25

Crosstabs Frequencies of Course and Tutoring Use

Tutoring status		Developmental	% of developmental students	Algebra	% of algebra students
Tutored anywhere		61	27.1	128	43.5
Not tutored anywhere		164	72.9	166	56.5
	Total	225	100.0	294	100.0
Used math lab		30	13.6	77	26.2
Not use math lab		191	86.4	217	73.8
	Total	221	100.0	294	100.0
Tutored outside math lab		38	17.0	73	25.1
Not tutored outside of math lab		187	82.9	218	74.9
	Total	223	99.9	291	100.0
Tutored anywhere		123	51.9	54	69.2
Not Tutored anywhere		114	48.1	24	30.8
	Total	237	100.0	78	100.0
Used math lab		98	42.1	43	55.1
Not use math lab		135	57.9	35	44.9
	Total	233	100.0	78	100.0
Tutored outside of the math lab		43	18.5	26	35.6
Not Tutored outside of the math lab		190	81.5	47	64.4
	Total	233	100.0	73	100.0

Note. Totals do not add to 834 due to missing data and some percentages do not add to 100 due to rounding.

Table 26

Chi-Square Values Between Course and Whether Students Seek Tutoring

	χ^2	*df*	*n*	*p*	*Cramér's V*
Sought any tutoring	52.25	3	834	.000	.25
Used the math lab	69.98	3	826	.000	.29
Used tutoring outside the math lab	15.78	3	820	.001	.14

Note. The expected cell count less than 5 is 0% for all χ^2.

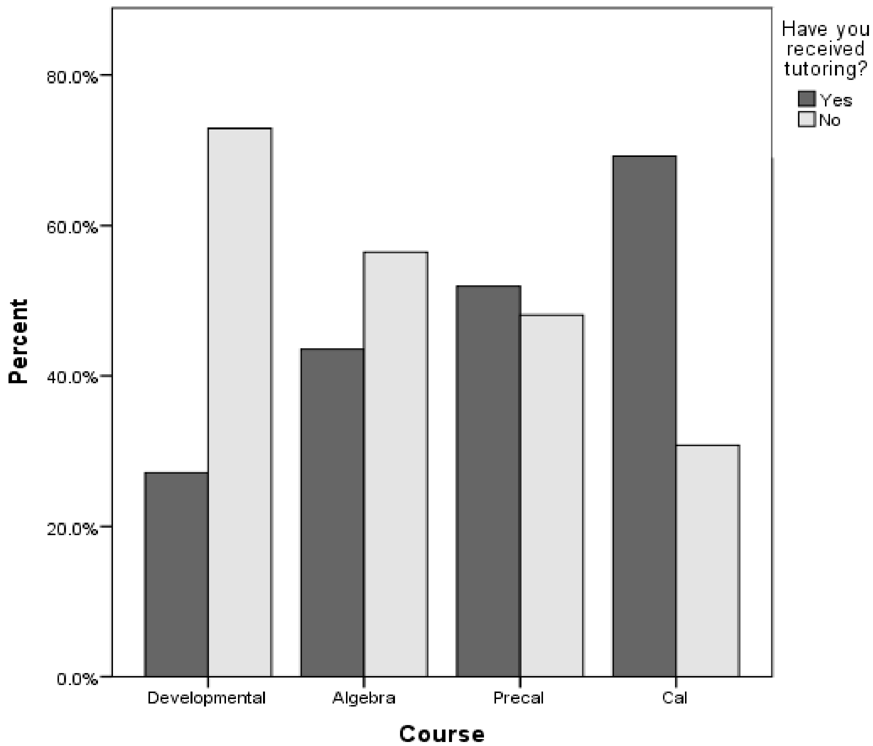

Figure 12. Bar graph of course compared to use of tutoring.

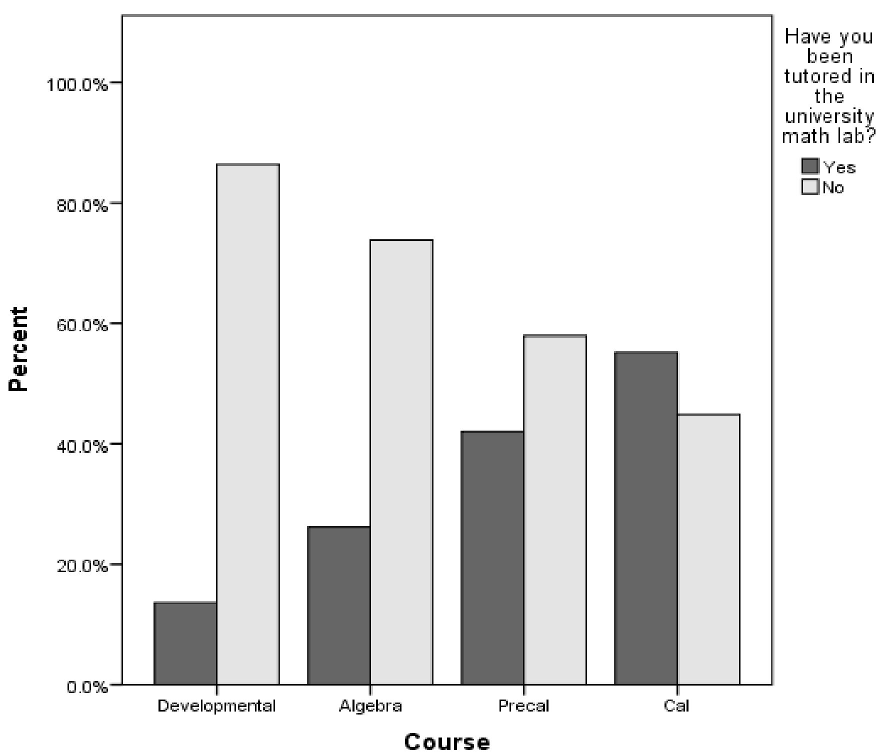

Figure 13. Bar graph of course compared to use of the math lab.

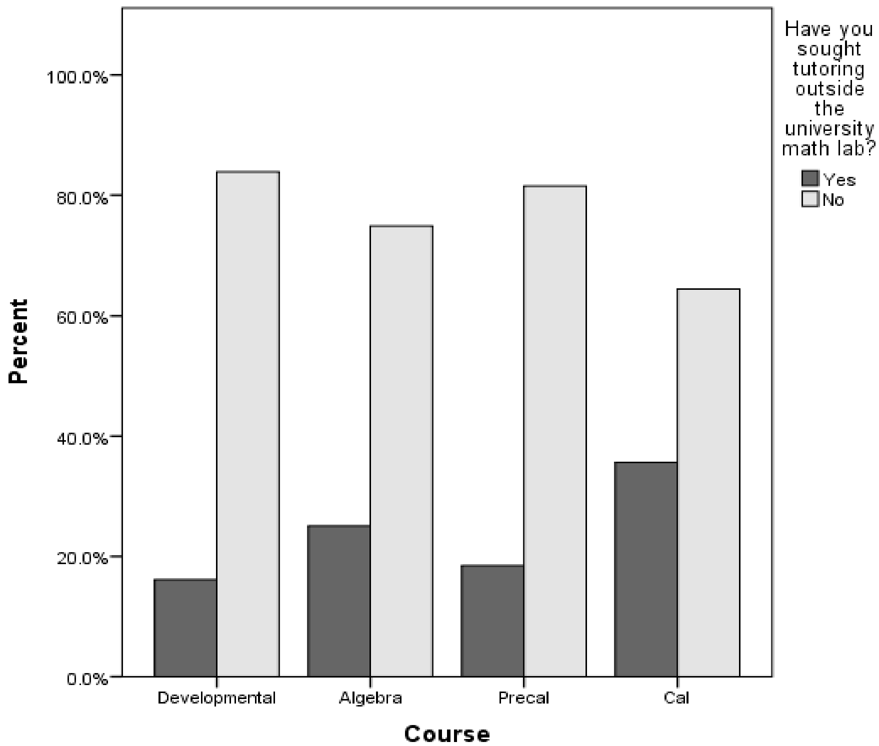

Figure 14. Bar graph of course compared to use of tutoring outside the math lab.

College classification. The frequencies of students who receive tutoring separated by college classification are displayed in Table 27. Since college classification and whether a student receives tutoring were both categorical variables, they were investigated using chi-squared test of association (Sheskin, 2007). The results can be seen in Table 28. Three significant associations were found. First between the college classification the student is enrolled in and whether the student uses tutoring. A Cramér's V=.25 indicated this to be a moderate association. The highest percentage of students who received tutoring were freshmen. However only 35.9% of the freshmen surveyed used tutoring. Around 60% of sophomores, juniors, and seniors received tutoring. Therefore even though more freshmen received tutoring than upperclassmen, freshmen were less likely to seek out tutoring than sophomores, juniors, and seniors. Next, another Cramér's V=.24 indicated a weak to moderate association between college classification and whether the student uses that math lab (Cohen, 1988). Only 22.8% of freshmen used the math lab, but 43.3% of sophomores, 50.6% of juniors, and 43.8% of seniors used tutoring. Freshmen were nearly half as likely to use the math lab as sophomores, juniors, or seniors. Even though freshmen were the largest classification tutored in the math lab, they were the least likely to seek tutoring in the lab. A third Cramér's V=.16 indicated a weak association between college classification and whether the student is tutored outside the math lab. The largest percentage of students who were tutored outside the math lab was freshmen. However, only 17.8% of freshmen were tutored outside the math lab compared to over 30% of sophomores, juniors, and seniors. Therefore freshmen were least likely to receive tutoring outside the math lab, but the students who were tutored outside the math lab are most likely to be freshmen.

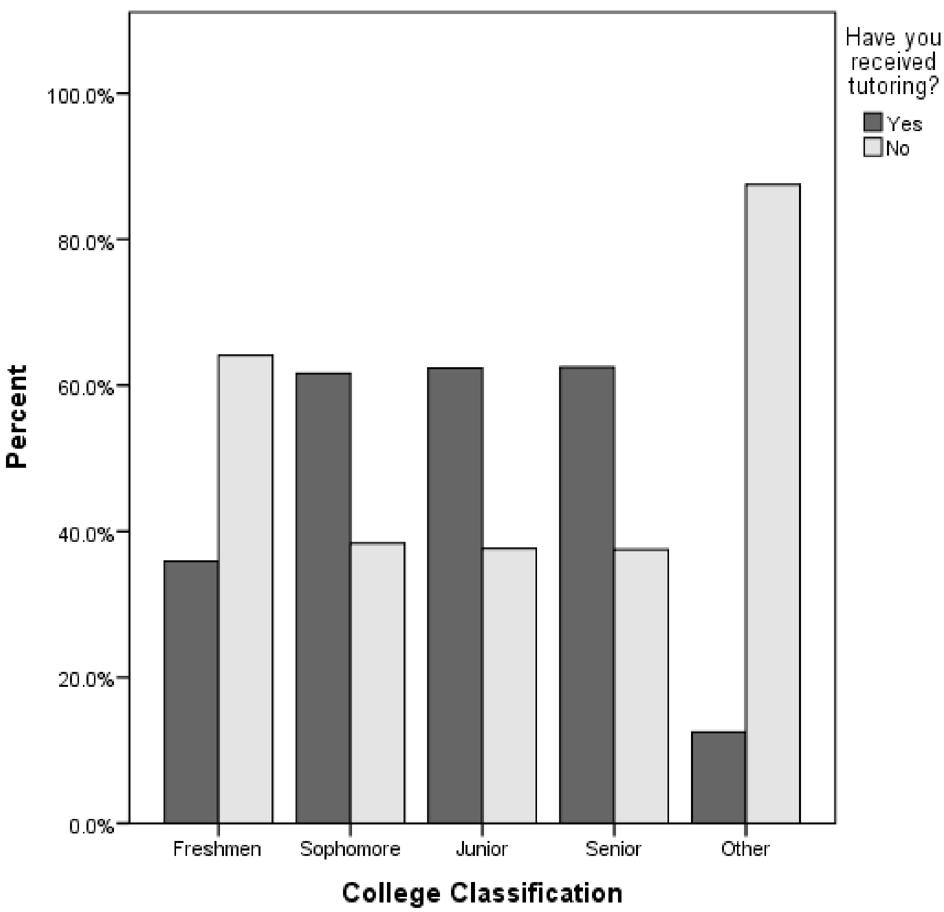

Figure 15. Bar graph of college classification compared to use of tutoring.

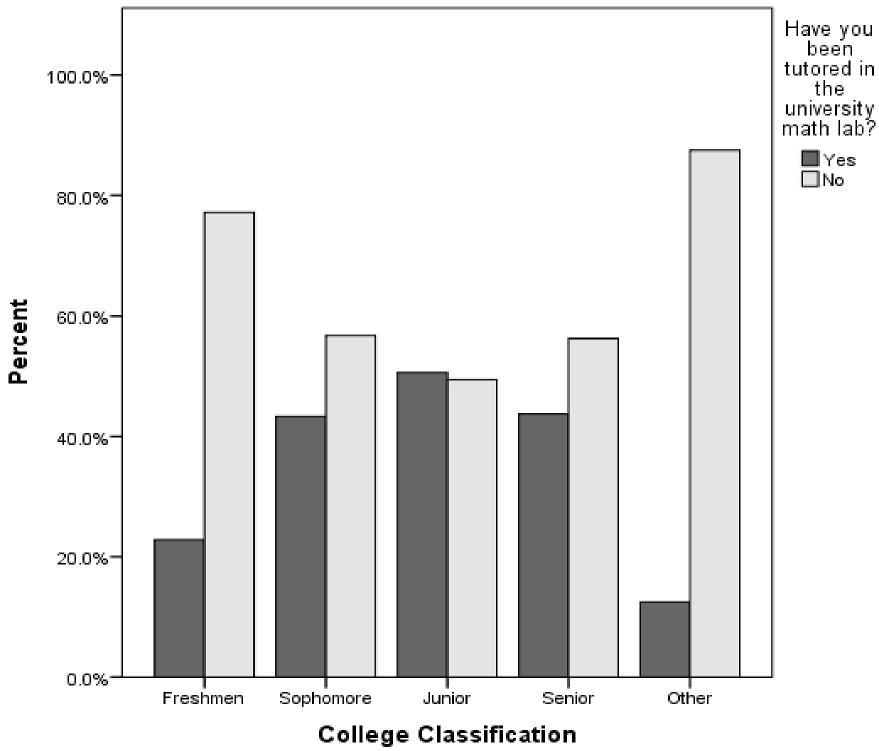

Figure 16. Bar graph of college classification compared to use of the math lab.

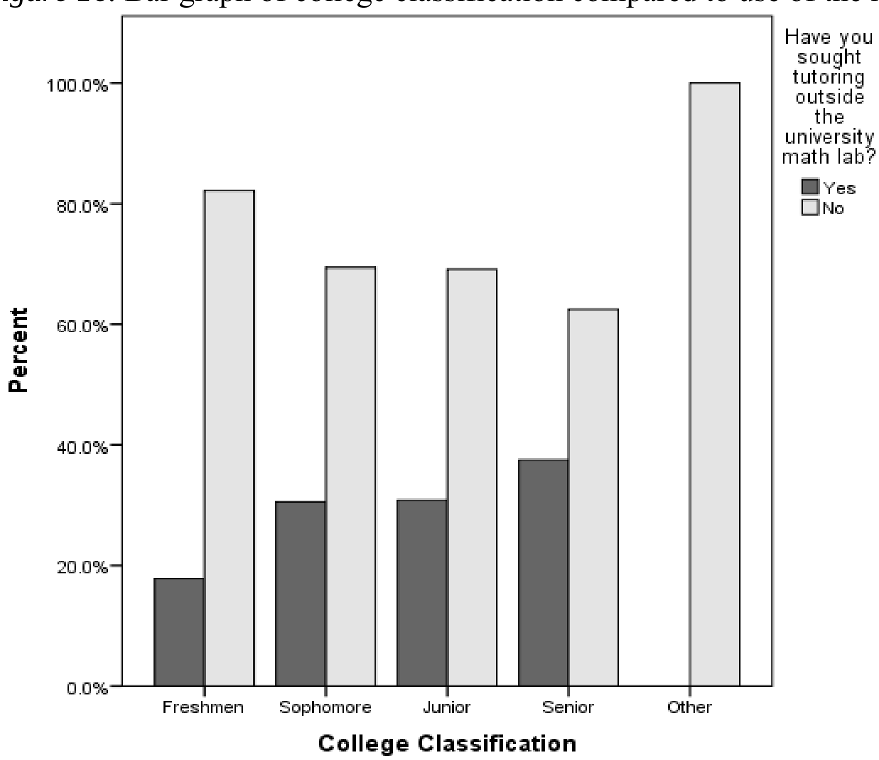

Figure 17. Bar graph of college classification compared to use of tutoring outside the math lab.

Table 27

Crosstabs Frequencies of College Classification and Tutoring Use

Tutoring status	Freshmen	% of freshmen	Sophomores	% of sophomores
Tutored anywhere	202	35.9	98	61.6
Not tutored anywhere	361	44.1	61	38.4
Total	563	100.0	159	100.0
Used math lab	127	22.8	68	43.3
Not use math lab	430	77.2	89	56.7
Total	557	100.0	157	100.0
Tutored outside of math lab	99	17.8	48	30.6
Not tutored outside math lab	457	82.3	109	69.4
Total	556	100.1	157	100.0

Tutoring status	Juniors	% of juniors	Seniors	% of seniors
Tutored anywhere	53	62.4	10	62.5
Not tutored anywhere	32	37.6	6	37.5
Total	85	100.0	16	100.0

Tutoring status	Juniors	% of juniors	Seniors	% of seniors
Used math lab	43	50.6	7	43.7
Not use math lab	42	49.4	9	56.3
Total	85	100.0	16	100.0
Not tutored outside math lab	25	30.9	6	37.5
Tutored outside of math lab	56	69.1	10	62.5
Total	81	100.0	16	100.0

Note. Totals do not add to 834 due to missing data and some percentages do not add to 100 due to rounding.

Table 28

Chi-Square Values Between College Classification and Whether Students Seek Tutoring

	χ^2	df	n	*p*	*Cramér's V*
Sought any tutoring	52.24	4	831	.000	.25
Used the math lab	46.85	4	823	.000	.24
Used tutoring outside the math lab	20.47	4	817	.000	.16

Note. The expected cell count less than 5 is 20% for all χ^2.

Native English speaker. The frequencies of native and non-native English speakers who receive tutoring are shown in Table 29. Since both whether the student is a native English speaker and whether a student receives tutoring were categorical variables, the relationship was investigated using chi-squared tests of association (Sheskin, 2007). The results can be seen in Table 30. The only significant association found was between whether the student is a native English speaker and whether the student uses the math lab. However a Cramér's V=.1 indicated this was a weak association (Cohen, 1988). Therefore, there is a weak relationship between whether the student was a native English speaker and whether the student used the math lab. Also, 27.4% of native English speakers and 37.7% of non-native English speakers surveyed used the math lab. Therefore, even though native English speakers made up the majority of those tutored in the math lab, a non-native English speaker was slightly more likely to use the math lab than an English speaker.

Table 29

Crosstabs Frequencies of Native English Speakers and Tutoring Use

Tutoring status		Native English speaker	% of native English speakers	Non-native English speaker	% of non-native English speakers
Tutored anywhere		264	43.0	102	46.4
Not tutored anywhere		350	57.0	118	53.6
	Total	614	100.0	220	100.0
Used math lab		168	27.4	80	37.7
Not use math lab		446	72.6	132	62.3
	Total	614	100.0	212	100.0
Not tutored outside math lab		136	22.5	42	19.4
Tutored outside of math lab		468	77.5	174	80.6
	Total	604	100.0	216	100.0

Note. Totals do not add to 834 due to missing data.

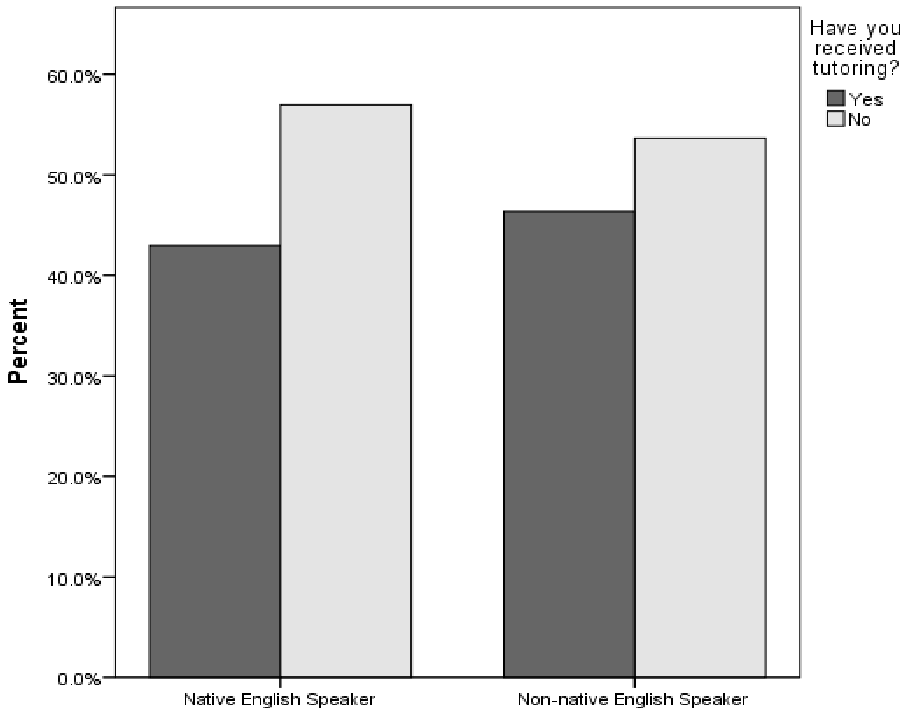

Figure 18. Bar graph of native and non-native English speakers compared to tutoring use.

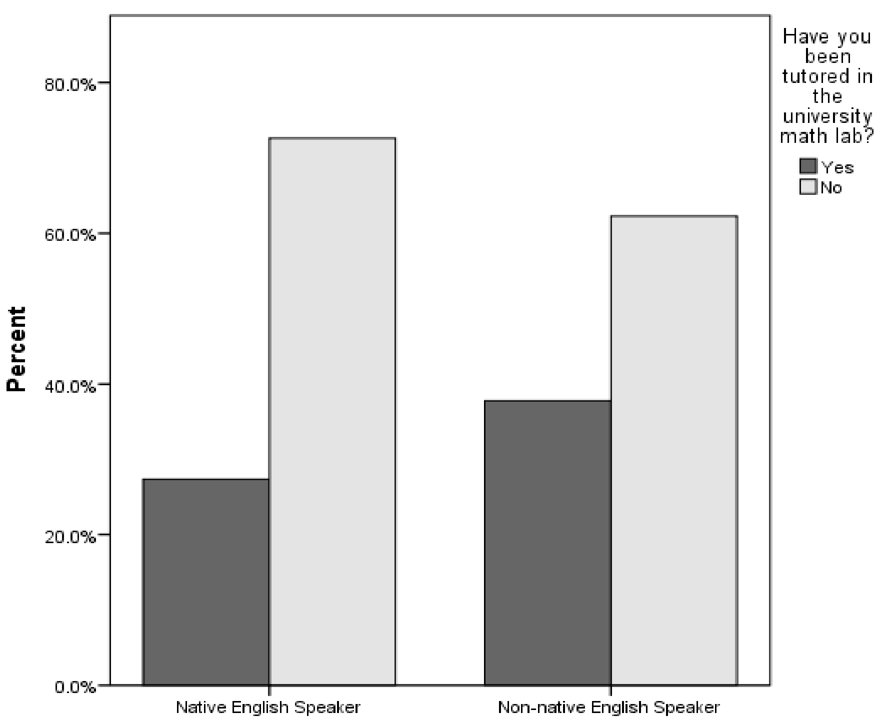

Figure 19. Bar graph of native and non-native English speakers compared to use of the math lab.

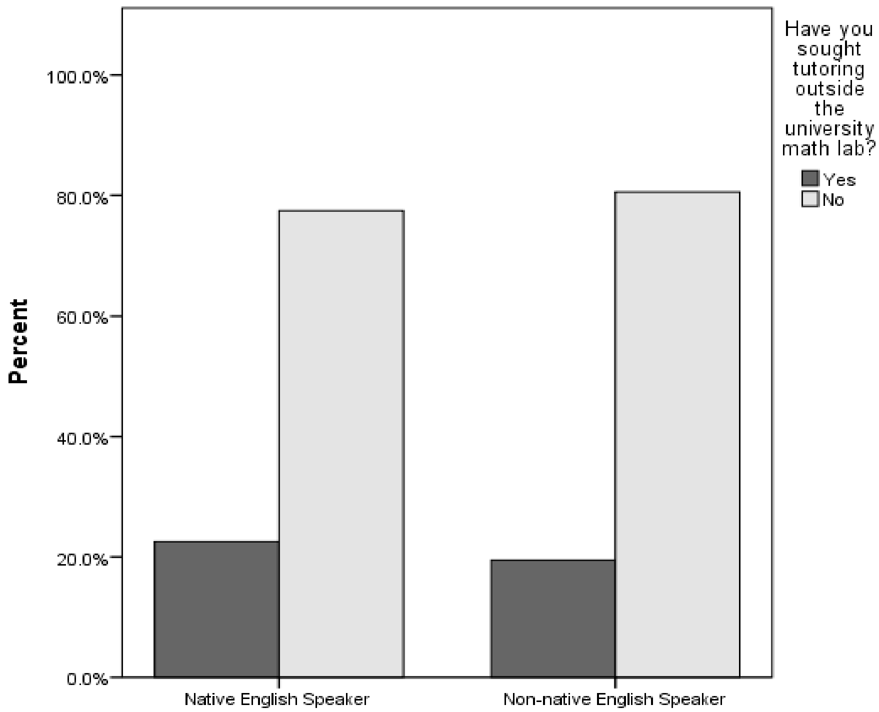

Figure 20. Bar graph of native and non-native English speakers compared to use of tutoring outside the math lab.

Table 30

Chi-Square Values Between Whether Students are Native English Speakers and Whether Students Seek Tutoring

	χ^2	*df*	*n*	*p*	*Cramér's V*
Sought any tutoring	0.74	1	834	.39	-
Used the math lab	8.07	1	826	.00	.1
Used tutoring outside the math lab	0.88	1	820	.35	-

Note. The expected cell count less than 5 is 0% for all χ^2.

Research question 3. How are hours spent in mathematics tutoring related to learning style and perceptions of the learning environment?

How is the number of hours spent in mathematics tutoring related to the way students prefer to process new information? The processing score is and ordinal variable measured from active to reflective. Norušis (2008) states that a Kendall's Tau-C test may be used to measure association between ordinal variables. The results are summarized in Table 31. One extreme outlier was removed. This case reported spending 30 hours a week both in the math lab and an additional 30 hours a week outside of the math lab each week. The only significant correlation found was a negative correlation between processing and hours per week spent in the math lab if tutored other than test week. The scatterplot of these two variables can be seen in Figure 21. The Kendall's tau suggests that for students who received tutoring other than test week, the more reflective the students were, the less time per week they spend in the math lab. No relationship can be assumed between processing and the other tutoring hour variables.

Table 31

Kendall's Tau-C Values Between Processing and Tutoring Hours

	τ	n	p
Other than Test Week			
Hours tutored	-.09	178	.08
Hours tutored in the math lab	-.19	118	.00
Hours tutored outside the math lab	.06	88	.44
Test Week Only			
Hours tutored	-.02	97	.78
Hours tutored in the math lab	-.02	56	.88
Hours tutored outside the math lab	-.03	43	.78

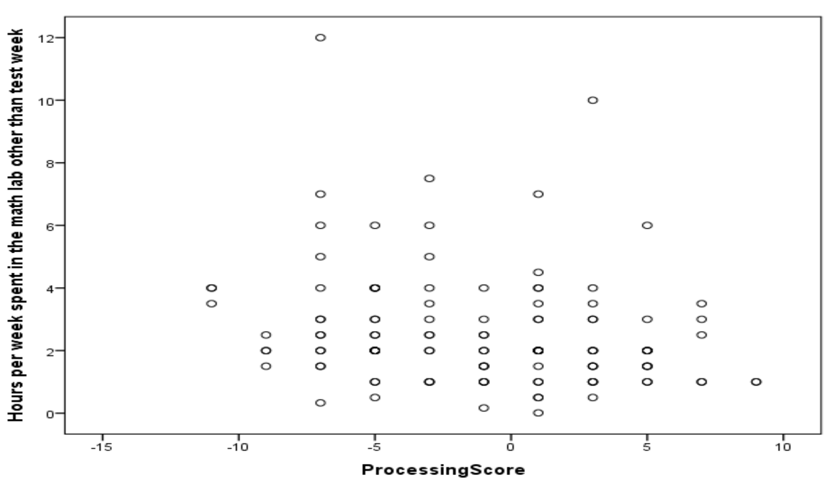

Figure 21. Scatterplot of processing versus hours spent in the math lab if used other than test week.

How is the number of hours spent in mathematics tutoring related to the way students prefer to take in new information? Input is measured from visual to verbal. To investigate relationships between input score and the hours spent in tutoring, a Kendall's tau-c was calculated for each tutoring hour variable. The results can be seen in Table 32. One extreme outlier was removed. This case reported spending 30 hours a week both in the math lab and an additional 30 hours a week outside of the math lab each week. No significant correlations were found. Therefore no relationship can be assumed between hours spent in tutoring and the way students prefer to take in information.

Table 32

Kendall's Tau-C Values Between Input and Tutoring Hours

	τ	n	p
Other than Test Week			
Hours tutored	-.02	179	.71
Hours tutored in the math lab	-.02	122	.76
Hours tutored outside the math lab	.18	80	.051
Test Week Only			
Hours tutored	-.00	99	.98
Hours tutored in the math lab	.02	59	.82
Hours tutored outside the math lab	-.01	42	.92

How is the number of hours spent in mathematics tutoring related to the way students prefer to perceive new information? Perception is measured from sensory to intuitive. To investigate relationships between perception score and the hours spent in tutoring, a Kendall's tau-c was calculated for each tutoring hour variable. The results can be seen in Table 33. One extreme outlier was removed. This case reported spending 30 hours a week both in the math lab and an additional 30 hours a week outside of the math lab each week. No significant correlations were found. Therefore no relationship can be assumed between the way a student prefers to perceive information and the number of hours spent in tutoring.

Table 33

Kendall's Tau-C Values Between Perception and Tutoring Hours

	τ	*n*	*p*
Other than Test Week			
Hours tutored	-.04	179	.48
Hours tutored in the math lab	-.02	119	.67
Hours tutored outside the math lab	-.09	82	.32
Test Week Only			
Hours tutored	-.06	98	.35
Hours tutored in the math lab	-.05	57	.60
Hours tutored outside the math lab	-.07	42	.46

How is the number of hours spent in mathematics tutoring related to the way students prefer to build understanding new information? Understanding is measured from sequential to global. To investigate relationships between understanding score and the hours spent in tutoring, a Kendall's tau-c was calculated for each tutoring hour variable. The results can be seen in Table 34. One extreme outlier was removed. This case reported spending 30 hours a week both in the math lab and an additional 30 hours a week outside of the math lab each week. No significant correlations were found. Therefore no relationship can be assumed between the way a student prefers to understand and the number of hours spent in tutoring.

Table 34

Kendall's Tau-C Values Between Understanding and Tutoring Hours

	τ	*n*	*p*
Other than Test Week			
Hours tutored	-.04	185	.48
Hours tutored in the math lab	-.01	123	.91
Hours tutored outside the math lab	-.04	85	.65
Test Week Only			
Hours tutored	-.03	99	.66
Hours tutored in the math lab	-.08	59	.49
Hours tutored outside the math lab	.01	42	.92

How is the number of hours spent in mathematics tutoring related to the way students perceive the learning environment? To address this question the variables tutor perceptions and space perceptions, tutee distraction, and tutor distraction had four values and were treated as ordinal independent variables. Kendal tau-c values were calculated to look for relationships between tutor perceptions and the tutoring hour variables (Norušis, 2008). One extreme outlier was removed. This case reported spending 30 hours a week both in the math lab and an additional 30 hours a week outside of the math lab each week. The results are summarized in Table 35. No significant correlations were found, which suggests that there is no relationship between perception and hours tutored.

Table 35

Kendall Tau-C Values Between Tutor Perceptions and Tutoring Hours

	τ	n	p
Other than Test Week			
Hours tutored	.03	150	.59
Hours tutored in the math lab	.09	97	.26
Hours tutored outside the math lab	-.01	73	.89
Test Week Only			
Hours tutored	-.01	98	.87
Hours tutored in the math lab	.06	59	.60
Hours tutored outside the math lab	-.16	41	.11

Following the tutor perceptions investigations, the relationship between space perceptions, Kendall tau-c values were calculated to look for relationships between space perceptions and the hours spent in tutoring. The same extreme outlier of 30 hours per week was removed before analysis. Table 36 summarizes the results. There was a significant correlation between hours tutored other than test week and space perceptions. The Kendall tau of -.15 indicates that there was a negative relationship between hours tutored other than test week and the perception of the tutoring space. This suggests that the higher a student felt about the tutoring space, the less time the student spent in tutoring outside of test week. However a view of the scatterplot in Figure 22 shows that this negative correlation may be due to the cases with space perception score around 3 who were tutored over 8 hours per week.

Table 36

Kendall Tau-C Values Between Space Perceptions and Tutoring Hours

	τ	*n*	*p*
Other than Test Week			
Hours tutored	-.15	152	.01
Hours tutored in the math lab	-.08	98	.29
Hours tutored outside the math lab	-.10	75	.22
Test Week Only			
Hours tutored	.02	99	.75
Hours tutored in the math lab	.02	60	.81
Hours tutored outside the math lab	-.08	41	.52

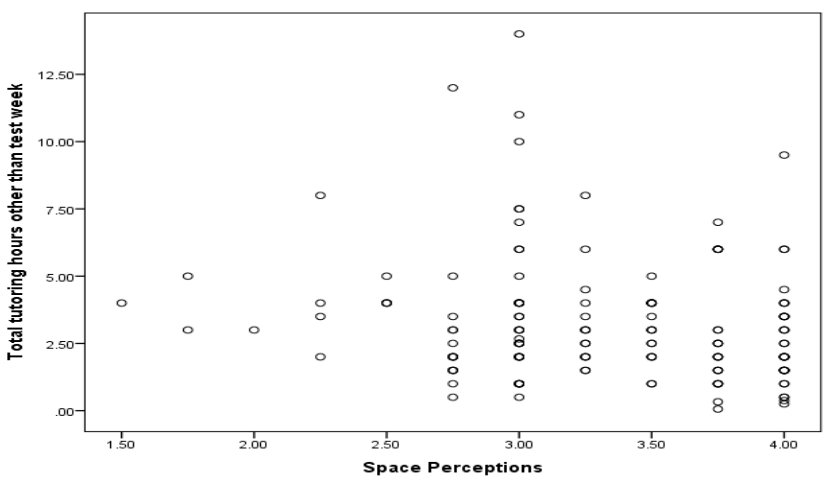

Figure 22. Scatterplot of space perception score compared to tutoring hours outside of test week.

Next the relationship between tutee distraction and hours spent in tutoring was investigated. Kendall tau-c values were calculated to look for relationships between tutee distraction and the hours spent in tutoring. As with tutor and space perceptions one extreme outlier of 30 hours per week was removed before analysis. Table 37 summarizes the results. No significant correlations were found, which suggests that there is no relationship between the tutees' perception of their distraction and number of hours spent in tutoring.

Table 37

Kendall Tau-C Values Between Tutee Distraction and Tutoring Hours

	τ	*n*	*p*
Other than Test Week			
Hours tutored	.02	151	.74
Hours tutored in the math lab	.04	97	.61
Hours tutored outside the math lab	.04	75	.71
Test Week Only			
Hours tutored	.07	99	.43
Hours tutored in the math lab	-.03	60	.78
Hours tutored outside the math lab	.21	41	.12

Finally, the relationship between tutor distraction and hours spent in tutoring was investigated. Kendall tau-c values were calculated to look for relationships between tutor distraction and the hours spent in tutoring. The extreme outlier of 30 hours was again removed before analysis. Table 38 summarizes the results. The only significant relationship found was between how distracted the tutee perceives the tutor to be and how many hours the student is tutored just in the math lab during test week. The negative correlation indicates that the more distracted the students felt the tutor was, the less time the students spent in the math lab during test week.

Table 38

Kendall Tau-C Values Between Tutor Distraction and Tutoring Hours

	τ	*n*	*p*
Other than Test Week			
Hours tutored	.00	152	.98
Hours tutored in the math lab	.06	98	.46
Hours tutored outside the math lab	-.00	75	.97
Test Week Only			
Hours tutored	-.14	99	.09
Hours tutored in the math lab	-.20	60	.049
Hours tutored outside the math lab	.05	41	.74

Research question 4. What is the difference in hours spent in tutoring among the demographic categories?

Gender. Norušis (2008) states an independent sample t-test should be used to test whether two populations' means are equal. To use an independent sample t-test, the distributions for each population must be normally distributed. The number of hours tutored in or out of the math lab was not normally distributed among males and females. Logarithmic, and root transformations did not produce a normally distributed population. When the population distributions are not normal, Norušis recommends using the non-parametric Mann-Whitney U test in order to test whether two populations' medians are equal. Therefore non-parametric Mann-Whitney U tests were performed to test whether there was a difference in the median hours spent in tutoring between genders. The results can be seen in Table 39. The only significant difference found was between median hours per week spent in the math lab if used other than test week. This suggests that there was a difference of number of hours per week spent in the tutoring lab if used other than test week for males and females. The median value for hours per week spent in the math tutoring lab for males was 2.5 hours, and the median for females was 2 hours. Since there is a significant difference in the median hours per week spent in the math tutoring lab between genders and the median for males was greater than females, there is evidence that males spend more time per week in the lab than females if the lab is used other than the week of a test.

Course. Norušis (2008) states that an analysis of variance should be used to test whether there is a difference in means among several independent populations. One of the conditions for an analysis of variance is that the data must be normally distributed among all the populations. Agresit and Finlay (2009) state that a sample greater than 30 is needed for normality to be assumed. Due to the low number of participants who reported the hours they spent in tutoring within each course, an analysis of variance could not be performed. According to Norušis when normality cannot be assumed, a non-parametric Kruskal-Wallis test should be performed to test for differences in the medians of several independent populations. Several Kruskal-Wallis tests were performed to test if the median hours spent in tutoring were the same for each course. The results can be seen in Table 40. The only significant difference in the medians found was for median hours tutored outside the math lab, if only tutored the week of a test. The result of the Kruskal-Wallis indicates that there at least for at least one course has a significant difference in the median hours tutored outside the math lab during test week than the other courses.

Table 39

Mann Whitney U Tests on Hours Tutored Between Genders

	U	*n*	*p*
Other than Test Week			
Hours tutored	4138.0	191	.42
Hours tutored in the math lab	1537.5	125	
			.048
Hours tutored outside the math lab	816.0	89	.36
Test Week Only			
Hours tutored	1179.0	104	.35
Hours tutored in the math lab	363.0	61	.41
Hours tutored outside the math lab	195.5	45	.14

Table 40

Kruskal-Wallis Tests on Hours Tutored Among Courses

	χ^2	*df*	*n*	*p*
Other than Test Week				
Hours tutored	7.1	3	191	.07
Hours tutored in the math lab	4.36	2	126	.27
Hours tutored outside the math lab	6.33	3	89	.89
Test Week Only				
Hours tutored	6.10	4	189	.19
Hours tutored in the math lab	1.57	3	61	.67
Hours tutored outside the math lab	9.31	3	45	.03

The Kruskal-Wallis indicated there was a significant difference in the median hours spent in tutored outside the math lab if only tutored during test week among the courses. Due to the low sample size, to test where this difference in medians was Mann-Whitney U tests were performed between two courses at a time (Norušis, 2008). The results are summarized in Table 41. A Mann-Whitney U found a significant difference between developmental and algebra, and between developmental and precalculus. The Mann-Whitney U test suggests that there is a difference of number of hours spent tutored outside the tutoring lab if only used during test week between developmental and algebra, and also between developmental and precalculus. The median hours tutored outside the math lab if only used during test week was 3 hours for developmental students, 2.25 hours for algebra students and 1.5 for precalculus students. Since there is a significant difference in the median hours tutored outside the math lab between developmental and algebra students, there is evidence that developmental math students who are were only tutored during test week spent more time in tutoring outside the math lab than algebra students who were only tutored during test week. Similarly there is evidence that developmental math students who were only tutored during test week spent more time in tutoring outside the math lab than precalculus students who were only tutored during test week

Table 41

Median Hours Tutored Outside the Math Lab During Test Week for Each Course

Course	Median hours tutored outside the math lab
Developmental	3.00
Algebra	2.25
Precalculus	1.50
Calculus	2.50

Table 42

Mann-Whitney U Tests on Hours Tutored Outside the Math Lab During Test Week Between Courses

Courses Compared	*U*	*n*	*p*
Developmental and algebra	33.5	27	.01
Developmental and precalculus	13.0	17	.03
Developmental and calculus	24.0	19	.08
Algebra and precalculus	47.5	26	.18
Algebra and calculus	72.0	28	.41
Precalculus and calculus	23.0	18	.15

College classification. As with testing for differences in tutoring hours among courses, due to the low number of participants within each college classification who reported hours spent in tutoring, non-parametric Kruskal-Wallis tests were performed to test if the median hours spent in tutoring were the same for each classification (Norušis, 2008). The results are summarized in Table 43. The only significant difference in the medians found was for hours spent in the math lab if only used during test week.

Table 43

Kruskal-Wallis Tests on Hours Tutored Among College Classifications

	χ^2	*df*	*n*	*p*
Other than Test Week				
Hours tutored	6.10	4	189	.19
Hours tutored in the math lab	3.71	3	88	.96
Hours tutored outside the math lab	.31	3	89	.89
Test Week Only				
Hours tutored	2.30	3	103	.51
Hours tutored in the math lab	6.68	2	60	.03
Hours tutored outside the math lab	2.94	3	45	.40

To test where this difference in medians was Mann-Whitney U tests were performed between two classifications at a time (Norušis, 2008). The results are summarized in Table 44. The results indicate a significant difference between freshmen and sophomores, and between sophomores and juniors. Therefore, there is evidence of a difference of number of hours spent in the tutoring lab if used during test week between freshmen and sophomores, and between sophomores and juniors.

Table 44

Mann-Whitney U Tests on Hours Tutored in the Math Lab During Test Week Between College Classifications

Courses Compared	*U*	*n*	*p*
Freshmen and sophomores	126.5	46	.02
Freshmen and juniors	215.0	46	.83
Sophomores and juniors	48.0	28	.02

The median value for hours spent in the math tutoring if only used during test week for each college classification is displayed in Table 45. The median hours for freshmen and juniors were both 2 hours. The median for sophomores was 3 hours. Since there is a significant difference in the median hours per week spent in the math tutoring lab between freshmen/juniors and sophomores and the median for sophomores was greater than freshmen, there is evidence that sophomores spent more time in the lab if only used during test week than freshmen and juniors.

Table 45

Median Hours Tutored in the Math Lab During Test Week for Each College Classification

Course	Median hours tutored outside the math lab
Freshmen	2.0
Sophomores	3.0
Juniors	2.0

Note. No Seniors or Others reported math lab use for test week

Native English speaker. The hours tutored were not normally distributed within the population of native or non-native English speakers. Therefore non-parametric Mann-Whitney U tests were performed to test if the median hours spent in tutoring were the same for each classification (Norušis, 2008). The results can be seen in Table 46. No significant differences in median hours spent in tutoring were found between native and non-native English speakers. Therefore, although being a native English speaker appears to make a difference in whether the student uses tutoring, once the student has decided to be tutored speaking English there is no evidence that it makes a difference of how many hours a student is tutored.

Table 46

Kruskal-Wallis Tests on Hours Tutored Among Native and Non-native English Speakers

	U	*n*	*p*
Other than Test Week			
Hours tutored	3574.5	191	.72
Hours tutored in the math lab	1625.5	126	.54
Hours tutored outside the math lab	579.5	89	.19
Test Week Only			
Hours tutored	969.0	104	.39
Hours tutored in the math lab	387.0	61	.72
Hours tutored outside the math lab	173.5	45	.70

Summary of Results.

Table 47

Summary of Results

Learning Style		Correlation	Strength
	Learning Style and Demographics		
	Processing and Course	Positive	Weak
	Perception and Course	Negative	Weak
	Perception and College Classification	Negative	Weak
	Understanding and College Classification	Negative	Weak
No correlations between learning style and tutoring use			
Uses Tutoring			
	Anywhere		
	Course		Weak to Moderate
	College Classification		Moderate
	Math Lab		
	Gender		Weak
	Note. For students tutored other than test week males are tutored more hours per week than females.		
	Course		Moderate
	College Classification		Weak to Moderate
	Note. Sophomores spend are tutored more than freshmen and juniors during test week.		
	Native English Speaker		Weak
	Outside The Math Lab		
	Course		Weak
	Note. Developmental and calculus students spend more time in tutoring than algebra and precalculus students during test week.		
	College Classification		Weak
When			
Other Than Test Week	Perception of the tutoring space and hours tutored	Negative	Weak
Test Week Only	Tutee perceives the tutor to be and hours tutored	Negative	Weak

Chapter 5: Conclusions

This study provided information about undergraduate students enrolled in mathematics courses who seek math tutoring. Few relationships were found, but the results still have implications. This chapter will first present the findings of the study followed by a comparison of the results to the previous literature. Next the limitations of the results will be discussed. Then the implications of this study will be investigated and the chapter will finish with suggestions for future research.

Discussion

The results from this study had four parts. The first was the relationship between learning style and demographics, second between learning style and mathematics tutoring, third the relationship between perceptions of the tutoring environment and tutoring, and fourth was the relationship between demographic information and mathematics tutoring. The results from each of these parts will be compared to the literature previously published on the subject.

Learning style and demographics. The results from this study were that students in developmental and algebra courses tended to have a lower sensory perception preference, while precalculus and calculus students tended to have a stronger sensory perception preference. Freshmen and sophomores tended to be less sequential than juniors and seniors.

Learning style and tutoring. The results from this study indicate that the popularity of tutoring is not strongly related to learning style. The results add support to the scholars who claim that the benefits of accommodating learning style are questionable (Coffield et al., 2004; Pashler et al., 2008). No significant relationships were found between any of the learning style components and whether the student sought tutoring. The only learning style that had a relationship with time spent in tutoring was processing for students who use the math lab other than the week of a test. No one learning style strongly preferred to be tutored over another. This supports Coffield et al.'s (2004) claim that the role that learning styles take is problematic. Learning style may still play a part in a student's desire for tutoring, but there is no definitive correlation between learning style and use of tutoring services.

Perceptions of the learning environment and tutoring. This study did not find evidence that any other perceptions of the tutor influence the use of tutoring. There was evidence to support the notion that creating a comfortable learning space had any benefit to the tutoring center as many scholars recommend (Bosch, 2006; Marland & Rogers, 1997; Rabow et al., 1999; Simmons, 2002). In fact the correlation found that for students who were tutored other than test week, the higher the student felt about the tutoring space, the less time the student spent in tutoring.

The level of tutor distraction was related to the hours spent in the math lab for those students who were only tutored during test week. This may support the literature's notion that students need to feel "valued as persons" (Bosch, 2006, p. 45) as these students may have felt that their time was not valued when the tutor did not focus on tutoring. However no support was found that any other perceptions of the tutor influenced on use of tutoring.

Demographics and tutoring. College learning assistance programs have been designed to support students adjusting to the college level of work (Arendale, 2010). However, this study found that freshmen sought math tutoring both in and out of the math lab at a lower rates than sophomores, juniors and seniors. Also, developmental math students were tutored in and out of the math lab at a lower percentage than any other course. Algebra had the next lowest percentage of students who sought mathematics tutoring. Calculus, the highest level math course surveyed, had the highest percentage of students who sought tutoring in the math lab. Although tutoring centers may have been developed for unprepared math students, the students in the highest level mathematics courses were the students using the tutoring resources that the universities offer.

Limitations of Results

The results of this study are subject to some limitations. First, the amount of time spent in tutoring does not necessarily reflect the time the student spent actively being tutored. Rather, how much time was spent waiting for the tutor to become available, and how much of the time the student was able to work without the tutor are also factors.

Tutors' previous knowledge of learning styles was not assessed. Neither were their teaching styles assessed. These tutors may have already had a basic knowledge of learning style and had the ability to adjust their teaching styles accordingly. Therefore, although no strong relationships between learning style and whether the student seeks tutoring were found, it cannot be concluded how helpful knowledge of learning styles is in tutoring.

In addition, this study found no positive correlation between perception of the tutoring space or the tutor. This indicates that students who had a higher perception of the tutor or tutoring space did not spend more hours in tutoring. However, only students who used tutoring reported their perceptions of the tutoring environment. This did not take into account the students who did not seek tutoring. For example, did a student never use the math lab because they did not like the atmosphere, or did the student try it once but did not feel the tutor was helpful? Knowing this would have given a fuller picture of the role perceptions of the tutoring environment played in a student's use of tutoring.

Implications

Although knowledge of learning style may make tutoring more effective, this study does not provide evidence to recommend that mathematics tutoring centers would benefit by changing the tutors' teaching style to match the learning styles of the students. Furthermore, the perceptions students have of the tutoring environment did not seem to influence how often they use tutoring services. Therefore, there does not seem to be any evidence to support making changes to tutoring space or training the tutors in a way to please the students will make any difference in the patronage of the tutoring center. Instead the evidence from this study suggests that the tutoring centers could benefit from reminding the tutors to keep focused on the students. This could be done with a supervisor who ensures that the tutors are not distracted while they are assisting students. On the other hand, it was only for the students who waited until test week to get tutored that tutor distraction was linked to fewer hours spent in tutoring. It is possible that these students perceive the tutor to be more distracted because they are rushing to cram before the test. Therefore it may advantage educators to find ways to convince these students into tutoring before the week of the exam.

No evidence was found to suggest that that tutoring centers will increase usage by making the tutoring center look aesthetically pleasing. Students do not appear to spend less time in tutoring based if their perception of the room is low. In spite of this, it should be noted that making a pleasant tutoring space could have benefits for the employees and it could make a subconscious difference to the tutees. However, the results from this study suggest that making changes to the physical space may not need to be a major priority. Instead, the evidence from this study suggests that the tutoring centers would benefit more from reminding the tutees to keep focused on the material. On the other hand, it was only the students who waited until test week to get tutored that tutee distraction was linked to hours spent in tutoring. It is possible that these students are spending more time in tutoring because their distraction is keeping them from focusing on studying. Furthermore, it is possible that these students are waiting until exam week to receive tutoring because they are distracted away from studying until they must cram before the test. Therefore, it may advantage tutoring centers to find ways to convince these students into tutoring before the week of the exam.

Learning assistance is geared to help students adjust to college level material; this would imply mostly freshmen or sophomores. However, this study found that these students used math tutoring less than juniors or seniors. It would also seem that developmental students would need the most assistance since they are by definition not ready for college level work. Logically algebra students would also need assistance because algebra students come from non-college level courses and thus would be the population needing help adjusting to college level work. However, this study found that developmental and algebra students used tutoring less than precalculus and calculus students. Postsecondary institutions may need to assess how they are advertising university sponsored tutoring. College instructors may need to consider how strongly they recommend tutoring to these students. The institutions of higher education might want to consider requiring tutoring for freshmen and/or developmental math in order to ensure that they are using these resources.

Although the percentage of native English speakers who used the math lab was very close to the percentage of non-native English speakers (in fact, the percentage of non-native English speakers who used the math lab was only slightly higher than that of native English speakers), most of the students who used the math lab were native English speakers. The weak correlation between whether the student is a native English speaker and whether the student uses the math lab is important. Once the students chose to use the math lab there was no difference in the amount of time spent in tutoring. This implies that if the postsecondary institutions can convince the non-native English speakers to use the math tutoring services then the students will continue to use them. This is especially significant since the United States Census Bureau (2014) found that 16.3% of Texas families, and over a third of American families do not speak English at home.

Recommendations for Future Research

Future research is needed in further investigating the interactions between learning style, perceptions, and tutoring. A starting place for future research would be to address the limitations of this study. First, it would be beneficial to explore why the students who never sought tutoring did not use the service. Did the students feel they did not need math tutoring, did they not like the atmosphere, did they not like the tutors, were the hours not convenient for them, and so on? Investigating this could lead to a better understanding of whether the student perceptions were involved in the decision to receive tutoring. This could also help the math labs understand why a lower percentage of developmental and algebra students sought tutoring than precalculus and calculus students.

It would also be beneficial to explore why the students who sought tutoring did so. Were these students recommended to get tutoring from the teacher, did they feel they needed it, were they more confident if they had a tutor, was it just a way to force themselves to get their homework done? An in-depth investigation of this could better help educators understand the role tutoring plays in these students' education. Knowing the reasons students do or do not seek tutoring can help postsecondary institutions decide on the best way to spend their resources. If it is found that students do not seek tutoring because they do not believe they need it then the institutions may want to find a way to convince these students to use this resource.

Math labs may also want to consider investigating the students who are and are not using their services. Why are male who use the math lab other than test week spend more time in tutoring than females? This could mean that females do not have as many questions, or it could mean that females are being rushed out of the lab. Why do developmental students spend more time in tutoring outside the math lab than algebra and precalculus during test week? Is there a reason why these students are not spending more time in the math lab during test week? Investigating whether there is a social stigma to seeking tutoring which makes females or younger students less likely to seek tutoring. Could these students feel that use of tutoring shows academic weakness?

Another opportunity for future research would be to assess the teaching style of the tutors in accordance with the teaching style model Felder and Silverman proposed to parallel their learning style model (Felder & Silverman, 1988). This way it could be determined whether the learning style components which had no relationship with hours spent in tutoring were because all the different learning styles were accommodated. Related to this, it would be beneficial to examine if the tutors have knowledge of learning styles. Graf et al. (2009) claimed that when teachers know the students' learning styles, it helps the teacher explain the material more effectively. Asking the tutors about their knowledge of learning styles and assessing how they use this knowledge in their tutoring could help explain the lack of relationship between learning style and tutoring.

Finally, it may be beneficial to look how grades relate to tutoring. Correlations between grades and use or frequency of tutoring may indicate whether tutoring helps academic performance. As Chapter 2, it is faulty to attribute high grades to tutoring (Baker et al., 2006). However, finding a correlation between tutoring and grades may convince some students who would not otherwise receive tutoring to do so. Looking for a correlation between grades and perceptions of the tutoring environment may also be beneficial. Could the way students feel about their tutor or the tutoring space influence their mathematics performance?

Baker et al. (2006) also point out that there are too many variables at work to credit tutoring for academic improvement. For example, while students are receiving tutoring, they are also learning material in the classroom. In addition, most students “have access to and are strongly encouraged to utilize alternate academic support services like instructor office hours, academic counseling, and learning support workshops” (Xu et al., 2001, para. 7). Therefore, it is impossible to credit any academic improvement to tutoring alone.

Tutoring has a long tradition in education. Although the effect tutoring has on academic performance is unknown it continues to be a large part of postsecondary institutions’ learning assistance programs (Rheinheimer et al., 2010). This study has found that the reasons why students continue to seek out mathematics tutoring in spite of the debatable effects may not be due to a learning preference that tutoring accommodates. However, more research should be done to understand the role tutoring plays in adults learning of mathematics.

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Appendices

Appendix A

STATEMENT OF PERMISSION TO USE THE INDEX OF LEARNING STYLES DIMENSIONS FIGURE

From: Richard Felder [rmfelder@mindspring.com]
Sent: Thursday, June 27, 2013 11:25 AM
To: Shirley, Matthew E.
Subject: Re: ILS visual aid

Dear Mr. Shirley,

You are welcome to reproduce the report form in your dissertation.

Sincerely,

Richard M. Felder
Hoechst Celanese Professor Emeritus of Chemical Engineering
N.C. State University
http://www.ncsu.edu/effective_teaching

Appendix B

INDEX OF LEARNING STYLES

 For information about appropriate and inappropriate uses of the Index of Learning Styles and a study of its reliability and validity, see <*http://www.ncsu.edu/felder-public/ILSpage.html*>.

Enter your answers to every question on the ILS scoring sheet. Please choose only one answer for each question. If both "a" and "b" seem to apply to you, choose the one that applies more frequently.

1. I understand something better after I

a) try it out.

b) think it through.

2. I would rather be considered

a) realistic.

b) innovative.

3. When I think about what I did yesterday, I am most likely to get

a) a picture.

b) words.

4. I tend to

a) understand details of a subject but may be fuzzy about its overall structure.

b) understand the overall structure but may be fuzzy about details.

5. When I am learning something new, it helps me to

a) talk about it.

b) think about it.

6. If I were a teacher, I would rather teach a course

a) that deals with facts and real life situations.

b) that deals with ideas and theories.

7. I prefer to get new information in

a) pictures, diagrams, graphs, or maps.

b) written directions or verbal information.

8. Once I understand

a) all the parts, I understand the whole thing.

b) the whole thing, I see how the parts fit.

9. In a study group working on difficult material, I am more likely to

a) jump in and contribute ideas.

b) sit back and listen.

10. I find it easier

a) to learn facts.

b) to learn concepts.

11. In a book with lots of pictures and charts, I am likely to

a) look over the pictures and charts carefully.

b) focus on the written text.

12. When I solve math problems

a) I usually work my way to the solutions one step at a time.

b) I often just see the solutions but then have to struggle to figure out the steps to get to them.

13. In classes I have taken

a) I have usually gotten to know many of the students.

b) I have rarely gotten to know many of the students.

14. In reading nonfiction, I prefer

a) something that teaches me new facts or tells me how to do something.

b) something that gives me new ideas to think about.

15. I like teachers

a) who put a lot of diagrams on the board.

b) who spend a lot of time explaining.

16. When I'm analyzing a story or a novel

a) I think of the incidents and try to put them together to figure out the themes.

b) I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

17. When I start a homework problem, I am more likely to

a) start working on the solution immediately.

b) try to fully understand the problem first.

18. I prefer the idea of

a) certainty.

b) theory.

19. I remember best

a) what I see.

b) what I hear.

20. It is more important to me that an instructor

a) lay out the material in clear sequential steps.

b) give me an overall picture and relate the material to other subjects.

21. I prefer to study

a) in a study group.

b) alone.

22. I am more likely to be considered

a) careful about the details of my work.

b) creative about how to do my work.

23. When I get directions to a new place, I prefer

a) a map.

b) written instructions.

24. I learn

a) at a fairly regular pace. If I study hard, I'll "get it."

b) in fits and starts. I'll be totally confused and then suddenly it all "clicks."

25. I would rather first

a) try things out.

b) think about how I'm going to do it.

26. When I am reading for enjoyment, I like writers to

a) clearly say what they mean.

b) say things in creative, interesting ways.

27. When I see a diagram or sketch in class, I am most likely to remember

a) the picture.

b) what the instructor said about it.

28. When considering a body of information, I am more likely to

a) focus on details and miss the big picture.

b) try to understand the big picture before getting into the details.

29. I more easily remember

a) something I have done.

b) something I have thought a lot about.

30. When I have to perform a task, I prefer to

a) master one way of doing it.

b) come up with new ways of doing it.

31. When someone is showing me data, I prefer

a) charts or graphs.

b) text summarizing the results.

32. When writing a paper, I am more likely to

a) work on (think about or write) the beginning of the paper and progress forward.

b) work on (think about or write) different parts of the paper and then order them.

33. When I have to work on a group project, I first want to

a) have "group brainstorming" where everyone contributes ideas.

b) brainstorm individually and then come together as a group to compare ideas.

34. I consider it higher praise to call someone

a) sensible.

b) imaginative.

35. When I meet people at a party, I am more likely to remember

a) what they looked like.

b) what they said about themselves.

36. When I am learning a new subject, I prefer to

a) stay focused on that subject, learning as much about it as I can.

b) try to make connections between that subject and related subjects.

37. I am more likely to be considered

a) outgoing.

b) reserved.

38. I prefer courses that emphasize

a) concrete material (facts, data).

b) abstract material (concepts, theories).

39. For entertainment, I would rather

a) watch television.

b) read a book.

40. Some teachers start their lectures with an outline of what they will cover. Such outlines are

a) somewhat helpful to me.

b) very helpful to me.

41. The idea of doing homework in groups, with one grade for the entire group,

a) appeals to me.

b) does not appeal to me.

42. When I am doing long calculations,

a) I tend to repeat all my steps and check my work carefully.

b) I find checking my work tiresome and have to force myself to do it.

43. I tend to picture places I have been

a) easily and fairly accurately.

b) with difficulty and without much detail.

44. When solving problems in a group, I would be more likely to

a) think of the steps in the solution process.

b) think of possible consequences or applications of the solution in a wide range of areas.

PERMISSION TO USE THE INDEX OF LEARNING STYLES

The following was retrieved from Felder and Soloman's *Index of Learning Styles* website at http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILS-faq.htm#research on February 8, 2013:

> The ILS is available at no cost to students and faculty at educational institutions to use for non-commercial purposes, and also to individuals who wish to determine their own learning styles. The commercial rights are held by North Carolina State University. While we have chosen to provide open access to the web-based instrument and so have voluntarily relinquished control over its use, we rely on the integrity of private sector users to help cover the expense of developing and maintaining it.

Appendix C

TUTORING INFORMATION AND DEMOGRAPHICS SURVEY

1. Age:

If you are under 18, then STOP HERE and turn in your survey.

2. Gender: ( )M ( )F

3. Education Level: ( )Freshmen ( )Sophomore ( )Junior ( )Senior ( )Other

4. Is English your first language? ( )Yes ( )No

5. Have you been tutored in the math lab at your university?

( )Yes. Go to question 6.

( )No. Go to question 7.

6. Do you only seek tutoring in the math lab other than the week of a test?

( )Yes I only get tutored in the math lab the week of a test

If Yes then how many hours per week do you spend in the math lab the week of the test?

( )No, I get tutored in the math lab other than test weeks.

If No, then on average how many hours per week do you spend in the math lab getting tutored?

7. Have you sought tutoring outside of the university math lab?

( )Yes.

On average how many hours per week do you spend in tutoring outside the math lab?

( ) No.

( )Yes I only get tutored in the math lab the week of a test

If Yes then how many hours per week do you spend in the math lab the week of the test?

If you answered "Yes" to question 5 **or** question 7, then answer the following questions with one of the following values.

1 = strongly disagree

2 = disagree

3 = agree

4 = strongly agree.

1. The tutors are able to answer my questions.
2. The tutors are able to explain concepts in more than one way.
3. The tutor treats me with respect.
4. The tutor lets me do the work.
5. The tutor makes time for me.
6. The tutor is dedicated to my success.
7. I often get distracted during tutoring.
8. The tutor often gets distracted during tutoring.
9. The tutoring environment is often a quiet place for me to get work done.
10. The tutoring environment provides enough light for me to get work done.
11. I find the tutoring environment aesthetically pleasing.
12. I find the tutoring environment comfortable.

Appendix D

SUBJECT CONSENT TO TAKE PART IN A STUDY OF LEARNING PREFERENCES OF UNDERGRADUATE MATH TUTEES
University of the Incarnate Word

I am Matthew Shirley a graduate student at University of the Incarnate Word working towards a doctorate degree in education with a concentration in mathematics education.

You are being asked to take part in a research study of learning styles, perceptions of the tutoring environment and time spent outside of class tutoring. I want to learn whether there is a correlation between learning styles and hours spent in the university's mathematics tutoring center. You are being asked to take part in this study because you are currently enrolled in a college math course and have had access to the mathematics-tutoring center this term.

If you decide to take part, we will administer a 44-question questionnaire to determine your learning styles, and a survey to determine the amount of time you spend in math tutoring, and how you feel about your tutoring experiences. The surveys will be administered only once and will take around 30 minutes to complete. There are no discomforts or risks involved in this study. Your only inconvenience will be the time it takes to complete the survey. If you participate in this study you will have the benefit of knowing your learning styles. This study will provide knowledge that may help math tutors become more efficient in their profession.

Everything learned about you in the study will be confidential. If the results of the study are published, you will not be identified in any way. Your decision to take part in the study is voluntary. You are free to choose not to take part in the study or to stop taking part at any time. If you choose not to take part or to stop at any time, it will not affect your current and future status at University of the Incarnate Word or St. Edward's University.

If you have questions now, feel free to ask us. If you have additional questions later or you wish to report a problem that may be related to this study, contact Matthew Shirley (210)-832-5601, meshirle@uiwtx.edu .
The University of the Incarnate Word committee that reviews research on human subjects, the Institutional Review Board, will answer any questions about your rights as a research subject (829-2759—Dean of Graduate Studies and Research).
You will be given a copy of this form to keep.
Your signature indicates that you (1) consent to take part in this research study, (2) that you have read and understand the information given above, and (3) that the information above was explained to you.

______________________________________ Signature of Subject
__________________/___________________ Date (Time)