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FACTORS RELATED TO STUDENT PERFORMANCE

IN STATISTICS COURSES IN LEBANON

by

Hiba Salim Naccache

Abstract of a Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

August 2012

ABSTRACT

FACTORS RELATED TO STUDENT PERFORMANCE

IN STATISTICS COURSES IN LEBANON

by Hiba Salim Naccache

August 2012

The purpose of the present study was to identify factors that may contribute to business students in Lebanese universities having difficulty in introductory and advanced statistics courses. Two statistics courses are required for business majors at Lebanese universities. Students are not obliged to be enrolled in any math courses prior to taking statistics courses. Drawing on recent educational research, this dissertation attempted to identify the relationship between (1) students' scores on Lebanese university math admissions tests; (2) students' scores on a test of very basic mathematical concepts; (3) students' scores on the survey of attitude toward statistics (SATS); (4) course performance as measured by students' final scores in the course; and (5) their scores on the final exam. Data were collected from 561 students enrolled in multiple sections of two courses: 307 students in the introductory statistics course and 260 in the advanced statistics course in seven campuses across Lebanon over one semester.

The multiple regressions results revealed four significant relationships at the introductory level: between students' scores on the math quiz with their (1) final exam scores; (2) their final averages; (3) the Cognitive subscale of the SATS with their final exam scores; and (4) their final averages. These four significant relationships were also found at the advanced level.

In addition, two more significant relationships were found between students' final average and the two subscales of Effort (5) and Affect (6).

No relationship was found between students' scores on the admission math tests and both their final exam scores and their final averages in both the introductory and advanced level courses. On the other hand, there was no relationship between students' scores on Lebanese admissions tests and their final achievement.

Although these results were consistent across course formats and instructors, they may encourage Lebanese universities to assess the effectiveness of prerequisite math courses. Moreover, these findings may lead the Lebanese Ministry of Education to make changes to the admissions exams, course prerequisites, and course content. Finally, to enhance the attitude of students, new learning techniques, such as group work during class meetings can be helpful, and future research should aim to test the effectiveness of these pedagogical techniques on students' attitudes toward statistics.

The University of Southern Mississippi

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Director

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Dean of the Graduate School

August 2012

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CHAPTER I

INTRODUCTION

The Context and Motivation

Lebanon is a country in the Middle East where higher education is very important for most families (Abboud, 1998). Higher education in Lebanon consists of technical and vocational institutes, colleges, and universities. The Lebanese University is the only public institution of higher learning. The Ministry of Education and Higher Education administrates the private and public universities (International Association of University, 2010). According to the World Bank database, the gross enrollment rate of tertiary education is 46.9 % for male, 56.3% for female, and 51.6% total (World Bank, 2009). The private enrollment share of tertiary education is 53.4 percent. Female students are seen in every university program or field of specialization. Following high school, Lebanese students may choose to study at a university, a college, or a vocational training institute. The number of years to complete each program varies (World Bank, 2009).

The Lebanese educational system offers a very high quality and international class of education. Lebanon has 41 nationally-accredited universities, several of which are internationally recognized (Infopro Management, 2007). The American University of Beirut (AUB) and the Université Saint-Joseph (USJ) were the first Anglophone and the first Francophone universities to open in Lebanon respectively (Infopro Management, 2007). The 41universities, both public and private, largely operate in French or English as these are the most widely used foreign languages in Lebanon (World Bank, 2009).

At the English-speaking universities, students who have graduated from an American-style high school program enter at the freshman level to earn their baccalaureate equivalence from the Lebanese Ministry of Higher Education.

This qualifies them to continue studying at the higher levels. Such students are required to have already taken the Subject Tests I and II (SAT I and the SAT II) upon applying to college, in lieu of the official admissions exams. Students who have graduated from a school that follows the Lebanese educational system are directly admitted to the sophomore year. These students are not required to take the SAT I or SAT II. In addition, some students choose to study abroad.

The United Nations assigned Lebanon an Education Index of 0.84 in 2005. The Lebanese curriculum is used at all public and private schools in Lebanon. Schools must apply both the Lebanese and foreign curricula simultaneously when they implement a foreign curriculum (French, English, or international) in a school (Skaf & Habib, 2008). In Lebanon, English, French and Arabic are taught from early years in schools. After primary education, English or French becomes the mandatory medium of instruction for mathematics and science for all schools (Skaf & Habib, 2008).

Students arrive at universities equipped with effective reasoning on statistical problems because they begin to learn statistics in grade eight (Kaissi, Jammal, Loutfi, & Chahine, 2008). During their last year in high school, they chose one of four tracks: Math, Science, Socio-Economic, or Philosophy. They must pass one of the four official admissions exams administered by the government at the end of the year in order to be enrolled in a university. Only the socio-economic exam includes statistics problems. Most students taking this exam plan to be business majors.

All forty universities in Lebanon require their science, math, and business students, regardless of major, to take one or more statistics courses. For example, the university where the study will be conducted requires its students to take at least two statistics courses in order to graduate. Students have to deal with demanding tasks such as learning and applying statistical procedures in these courses (Murtonen & Lehtinen, 2003). The first course is introductory statistics, the second is intermediate statistics, and the third is advanced statistics. The third course is not required but it is offered as an elective.

However, these universities have no requirement for a pre-requisite math course before students take the statistics courses. Therefore, it is important to investigate the characteristics needed for Lebanese students to succeed in statistics courses. Several factors are assumed to affect student performance. In studies carried out in Italy, high achievement in statistics courses was shown to be related to positive attitudes toward statistics, low anxiety levels toward statistics, and mathematical competence (Chiesi, & Primi, 2010; Primi & Chiesi, 2007).

This study will be the first in Lebanon that will focus on measuring factors and effects on Lebanese student achievement in both the introductory and intermediate business statistics courses required in business majors. Specifically, the researcher explored three factors that may affect the performance of students in statistics courses in Lebanon: (1) students' attitude toward statistics; (2) students' math scores in the Lebanese official admissions exams; and (3) students' math skills on a modified math quiz administered during the last week of the course (Ballard & Johnson, 2004).

Students' gender and grade point average from the semester prior to their enrollment in the statistics course were also investigated.

Business students in Lebanon and other countries such as Spain and Germany are required to enroll in statistics and quantitative-based research methodology courses (Carmona, 2005; Osipow, 1973). Teaching statistics to business students helps prepare them to understand and to use statistical data in their field of study. As documented in many educational contexts, the instructors of as well as students enrolled in statistics courses often encounter difficulties (Carmona, 2005; Osipow, 1973). Teachers often experience frustration as they try to help their students learn statistics. Students are troubled in dealing with these disciplines, and they often attain low levels of performance on examinations. Moreover, they sometimes fail. For example at the Lebanese International University (LIU), 500 students enrolled in the statistics courses, but only 200 students registered for the following course (LIU, 2010). Because of this, these courses delay the completion of the degree program, and in some cases, are an obstacle to the attainment of the degree.

Negative affective responses to statistics are common among undergraduate students enrolled in business statistics courses in Spain (Carmona, 2005). Most students, in particular Arabic students in United Arab Emirates (UAE), consider statistics courses as the major obstacle toward achieving a high grade point average (GPA) (Aldogan & Aseeri, 2003). The researchers noticed that the language barrier was not the reason behind Arabic students' attitudes toward statistics, since Aldogan & Aseeri (2003) translated the attitude toward statistics survey designed by Wise in 1985 to the Arabic language in order to investigate the effect of the cognitive and non-cognitive factors on

students' performance in statistics courses. The survey scores were found to be correlated with cognitive factors such as basic mathematical skills, pre-knowledge in statistics, and course grade; also scores were correlated with non-cognitive factors such as gender and number of previous mathematical courses completed (Aldogan & Aseeri, 2003). Previous research in this area examined statistical performance in relation to three classes of variables: anxiety, attitude and ability (Adams & Holcomb 1986; Lalonde & Gardner, 1993). Further studies also found an association between attitude toward statistics and student achievement (Zimmer & Fuller, 1996) by checking Statistics anxiety and attitude.

Further studies contend that beyond the difficulty of statistics reported by students, statistics as a discipline related to the math domain is itself a source of difficulties for students, especially for those who hold unfavorable beliefs with respect to their prior achievement in math (Tomasetto, Matteucci, Carugati, & Selleri, 2009). Studies have yielded highly mixed results as to differences in male and female student performance in statistics courses. Some results revealed that students taught by a professor of the opposite sex performed significantly worse than students taught by a professor of the same sex (Haley, Johnson, & Kuennen, 2007).

Theoretical Foundation of the Study

How statistics courses are best taught? Over the past decades numerous articles have been published on this subject, as many instructors and researchers described their best way of teaching statistics courses. There is probably no best way to teach statistics. Numerous assumptions can be made as to the nature of good statistics courses. What is considered the best way to transfer knowledge and skills with respect to statistics, especially to freshmen?

There seems to be a widespread confusion about theory and practice in discussions of statistical education. Current curricula in universities suggest there is a dichotomy of things to learn -- some courses teach theory, occasionally called mathematical statistics, while some teach practice, the latter being called service or application courses. But this dichotomy has had very unfortunate consequences for the learning of statistics. Without a deeper understanding of the theory, students will not be able to adapt the statistician's questions to a real scientific context. In other words, the theory and practice of statistics are inseparable, because the theory is about the practice, and the practice should be according to the theory. The pedagogic separation of theory and practice is unwise. In this chapter the researcher will link statistics learning to three theories: Connectivism, Constructivism, and Expectancy Value Theory (EVT)

Connectivism theory

Connectivism suggests that knowledge exists in the world rather than in the head of an individual. The roots of connectivism, or networked learning, were first proposed in the 1970s when Ivan Illich presented his ideas on deschooling education and encouraged a movement toward student-centered, socialized learning opportunities. His view was utopian in its ultimate manifestation, and in view of today's globalized environment there is evidence his ideas are becoming reality. This theory is also related to the Activity theory of Vygotsky (1929) which speaks about the existence of knowledge within groups of people who share activities and knowledge. It also bears some similarity with the Social Learning theory of Bandura (1954) where people learn through contact. Connectivism is based on these two theories but emphasizes the effect that technology has on how people live, how they communicate, and how they learn. Thus, Connectivism

learning theory places emphasis on the importance of instructing students to search for, filter, analyze and synthesize information in order to obtain knowledge. In general, online community members started to learn from each other rather than depend on official, published works. In today's digital age, information is continually being developed, distributed and acquired.

Connectivism theory takes this fact into consideration. For learners, The ability to draw distinctions between important and unimportant information is vital. The ability to recognize when new information alters the landscape based on decisions made yesterday is also critical (Siemens, 2008a, 45). Individuals are constantly making connections to ever changing and evolving networks. As digital technology evolves and new methods for integrating instructional technology in the college classroom emerge, new learning theories will develop. Perhaps the human mind is being rewired to process information differently in light of our affinity with digital technology and the networked learning process. This is an exciting time to be involved in education as radical shifts in educational technology and e-learning are certain to occur over the next ten years.

Research shows that the most successful learners of mathematics at the primary level are those whose teachers make connections within the subject; they are called connectionist teachers. In addition, it was clear that those teachers with a strong connectionist orientation were more likely to have classes that made greater gains over the two terms than those classes of teachers with strong discovery or transmission orientations (Askew, Brown, Rhodes, Johnson, & William, 1997).The growing complexity and constant change of knowledge requires a new approach to learning. Today, large companies are moving to global web based services which enable

economies of scale not previously possible. The maturing of the World Wide Web has enabled web based services that are globally accessible and integrated with desktop computing and has given rise to the learning theory proposed by George Siemens in *Connectivism: A Learning Theory For The Digital Age* (Siemens, 2004). Based on Siemens' work, connectivism can be an alternative learning theory for the new knowledge era especially in teaching statistics where interchanging data between learners can improve their understanding of statistical applications.

Behaviorism, cognitivism, and constructivism as learning theories, distinct from theories about the use of computers in education, continue to be dominant in an age when the use of computers and the World Wide Web have revolutionized learning. Siemens (2004) suggests that these learning theories are not in step with the environment within which learners engage today. His proposal attempts to merge accepted theories of learning with the digital age into a new understanding. This can be closely related to statistics learning where published data is used more often in research. For Siemens, behaviorism, cognitivism and constructivism are the three broad learning theories most often utilized in the creation of instructional environments. These theories, however, were developed in a time when learning was not impacted through technology. Over the last twenty years, technology has reorganized how we live, how we communicate, and how we learn.

Learning needs and theories that describe learning principles and processes should be reflective of underlying social environments (Siemens, 2004).According to Siemens, behaviorism, cognitivism and constructivism focus on learning that occurs inside a person and fail to address learning that occurs outside of people and also how learning

happens within organizations. Siemens argues that the inclusion of technology and connection-making as learning activities begins to move learning theories into a digital age.

Other writers, such as John Seely Brown, reflect aspects of connectivism (Siemens, 2004). Brown has argued for almost a decade that the Internet leverages the small efforts of many with the large efforts of a few. Rushby has talked about the emancipator paradigm reducing the students' load and Bosco (2004) talks about learning as part of a community which reflects the non-sequential, iterative development of knowledge. Although connectivism is related to the understanding of data output, this study will be related to another theory, the EVT.

Constructivism theory

Another model suggested by Moore in 1992 can be applied toward a more direct way of learning by students instead of a theoretical approach. His constructivist view means that students work actively toward constructing their own knowledge and combining it with the knowledge they already have. Moore proposed in 1997 that students actually learn by doing and performing research. Thus teachers will discuss the content and coach the students in doing class exercises instead of telling them what to learn (Bryce, 2005; Moore, 1997). Students 'construct' their own knowledge on what they already know about a topic. This approach has advantages for both teaching and learning such complex skills as statistics (Hoogveld, 2003; Karagiorgi & Symeou, 2005). This view was adopted by the American Statistical Association in 2001. Moore divided the content of statistics courses into three parts: (a) Organization and summary of data, where students learn to look at data and to uncover patterns using statistical descriptions

and graphic displays; (b) Production of data, where students familiarize themselves with techniques such as sampling and setting up data collection methods; and (c) Inference, where students learn how to interpret tests and how to look upon (causal) relations between data using concepts such as significance.

This educational view that emerged during the first half of the 1990s not only changed the perspective for students, it also changed the teachers' perspective. This approach is also known as the data driven approach to statistics education (Roiter & Petocz, 1996). Where the content of the course is concerned, a number of suggestions have been made over the years:

1. Do not use too many formulas. Teach concepts first, then methods.

2. The cookbook approach does not work. Instead, use real-life data and place it in context, as realistic data or simulations motivate students to learn (Bradstreet, 1996).

3. The emphasis is on reasoning and the interpretation of results. Of course, some calculating is involved, but because of all the automated systems the calculations can be kept to a minimum.

4. Move from simple to complex. First use descriptions and graphical displays before turning to probability and testing. Step by step, students will learn how to choose and use methodological and statistical tools and instruments.

5. Only use a more complex theory when it is absolutely necessary with respect to probability and inference. The complexity of those two main statistical topics

often makes it difficult for students to understand. Teachers need to make these

subjects understandable by using interesting and easy real-life examples and

data (Cobb & Moore, 1997; Moore, 1992).

Students in introductory courses in statistics should be taught to learn statistical

reasoning before computing methods and learning complex formulas (Bradstreet, 1996).

Statistical reasoning is defined as the way people reason with statistical ideas and make

sense of statistical information (Garfield & Gal, 1999; Garfield, Hogg, Schau, &

Whittinghill, 2002).The main question that remains is *What should students learn and*

how should they learn it? (Moore, 1997). This means that technology serves pedagogy,

and that mathematics serves statistics only when it is absolutely necessary to understand

statistical concepts. In that way, statistics courses become more feasible, understandable

and enjoyable for all students, not only for a small mathematically oriented group.

Expectancy Value theory

The Expectancy Value Theory (EVT) is a model for explaining achievement

related choices (Wigfield, Tonks, & Eccles, 2004). The general model development

started in the 1930s with Lewin and Tolman, and it was further developed into a general

model of achievement motivation by Atkinson (Schunk, Pintrich, & Meece, 2008). It has

known many applications in achievement related research, among them learning

behavior. According to the basic theory, achievement behavior can be looked upon as a

function of the expectancies for a student, the goals toward which he/she is working and

the task value of the student. When the student has more than one choice, he or she will

choose the option with the best possible combination of expected success and value

(Verhoeven, 2008).

Eccles and Wigfield (2002) believe attitudes are multi-dimensional, that is, that attitudes are composed of constructs or factors that, although related, are distinct. The three expectancy-value factors of most use in statistics education include (1) Expectancies for Success - students' self-concepts regarding their ability to do statistics successfully; (2) Task Difficulty - students' perceptions of the difficulty of statistics; and (3) Task Value - students' perceptions of the value of doing statistics successfully. Each of these three factors suggests an important component to attitudes toward statistics. In addition, students' perceptions of their past academic performances (in math and in statistics, if they have had previous experience in the later) influence each of these three factors (Schau, 2003).

This model explicitly deals with the relationship between beliefs and attitudes. According to this theory, an attitude reflects the degree to which a person likes or dislikes an object, where the term object can refer to any aspect of the individual's world. Importantly, the theory is developed to predict specific attitudes in specific contexts (Ajzen & Fishbein, 1975). In this study the specific behavior of achieving high grades in the statistics course was the goal. The individual's attitude toward a behavior can be predicted by the salient beliefs that he or she holds about performing the behavior. It should be noted that the beliefs must correspond to the specific behavior concerning action, target, context and time in order to permit understanding and prediction of the attitude (Ajzen & Fishbein, 1975). That is, in order to predict the attitudes of scoring high, one should explicitly assess the beliefs of the consequences of performing that particular behavior (i.e. the expected consequences of high scores).

Beliefs associate an object with certain attributes. In the case of behavioral beliefs, the object is the behavior of interest and the associated attributes are the expected consequences of that behavior. Consequences can be good or bad and of varying magnitude. For instance, a student may believe that his high grade on the math admissions exam may lead to a high score in his statistics courses. The strength of an individual's belief is captured by his or her subjective probability that performing a behavior will lead to a certain outcome. Returning to the example above, the student may be very certain that high math skills or high math admissions scores will lead to improved performance (although to a small extent).

According to the original formulation of the expectancy-value model, a person's attitude toward a particular behavior can be predicted by multiplying his or her evaluation of each behavior's expected consequences by the strength of the belief that performing the behavior will lead to that consequence and then summing the product across all beliefs (Ajzen & Fishbein, 1975). However, empirical tests of this model have revealed that the interaction of evaluation of expected consequences on the one hand and the strength of the belief on the other fails to give significant results (Bagozzi, 1992), leading to a questioning of the multiplicative combination of beliefs and evaluations (Desharnais, Valiquette, Valios, & Godin, 1988). More specifically, the strength of the belief dimension has failed to contribute to the prediction of attitude (Pieters, 1988). Therefore, the researcher focused solely on expected consequences in the current analyses.

EVT has been used to understand motivations underlying individuals' behaviors. Focus has been placed on intent, as the immediate precursor to a particular behavior. This theory proposes that if one can determine the elements that impact intention, then one can

more accurately predict whether an individual will engage in a particular behavior. Likewise, it proposes that by changing an individual's perceptions of potential outcomes, one can alter the individual's intent. The basis of the theory is that "individuals choose behaviors based on the outcomes they expect and the values they ascribe to those expected outcomes" (Borders, Earleywine, & Huey, 2004, 539-541).

The level of one's willingness to perform a particular behavior is dependent on (a) the extent to which the individual believes a consequence will follow; and (b) the value the individual places on the consequence (Mazis, Ahtola, & Kippel, 1975). The more attractive a particular outcome is to the individual, the more likely the person will engage in the behavior. Similarly, as the number of positive outcomes increase, the motivation to engage in the behavior will increase. Expectancy itself is defined as "the measurement of the likelihood that positive or negative outcomes will be associated with or follow from a particular act" (Mazis et al, 1975, 38-40). Thus, the individual's outcome expectations affect one's attitudes toward the behavior. In addition to the expected outcome, the value the individual places on the outcome influences the individual's intentions.

Applying the EVT, Godin & Kok (1996) reported various outcomes that impact students' motivations in college. Many of these outcomes were seen as short-term goals, including the perceptions of successful course completions. Students were more willing to increase their efforts in a course if they valued increasing their grades. For instance, if students recognized that a higher grade would increase their grade point average and they valued this increase, they would be more likely to heighten their effort in courses. Other factors that heightened efforts included increases in self-esteem, academic success, and job opportunities post graduation.

Even though the EVT has been used to predict the intentions that will impact behavior, there are a number of limitations to the theory. One of the main weaknesses of the theory is the focus on limited cognitive processes. Borders et al. (2004) found that individuals choose from a variety of alternatives and thus must examine a variety of expectancies before choosing to engage in behaviors. Among the potential alternatives of decisions that can be made, some appear more attractive than others. For example, it appears individuals are likely to intend behaviors that have been positively reinforced by successful outcomes and by other individuals in social networks (Bandura, 1977).

Structure of Dissertation

Following this introductory section, Chapter II reviews the literature in (1) the reform movement in statistics education; (2) the EVT and its relation to the attitude toward statistics; (3) the empirical analysis on the determinants of student academic achievement; (4) the results of the Lebanese Civil War on education; and (5) the factors affecting students' performance in statistics courses. In the first two sections, the reform movement over the past decade of statistics education will be discussed, followed by the origin of the EVT and its application in this study. Next, the empirical findings of the determinants of student achievement in the U.S. as well as in Lebanon will be reviewed. In the last section of Chapter II, a review of the results of other studies concerning the factors studied in this dissertation will be discussed, followed by a discussion of the instruments that will be used in this study.

Chapter III presents and discusses the methodological design and the data collection of this study. The former includes three identification strategies including the instrumental variable (IV) design, the dependent variable (DV), and the multiple

regression models. The latter discusses and documents the data collection and data process from the aspects of sampling strategy, questionnaire design, field work of data collection, data entry, computation of sampling weights, and index construction. Reliability measures of selected variables are reported at the end of this chapter.

Problem Statement

The present study is the first study identifying student characteristics most associated with success in business statistics courses in Lebanon. This study examined a large number of factors that may affect students' achievement in introductory business courses. One factor that was studied was students' mathematical skills, since Lebanese students are not required to take any math course prior to the introductory business statistics courses, which is not the case in most universities around the world.

To determine which factors are important for student success, the researcher examined (1) the students' attitudes toward statistics by using the most recent Survey of Attitude Toward Statistics (SATS) designed originally by Schau in 1995 and updated by her in 2003, and viewing the effect of each subscale on the final grades of the students; (2) the students' math scores in one of the four versions of the Lebanese admissions exams; (3) the students' scores on a test of very basic mathematical concepts, (4) the students' grade point average; and (5) gender effect.

The results obtained from this study may be helpful, first, for universities in Lebanon to reconsider their decision about not requiring any prerequisite math courses before taking the business statistics course; and second, for the ministry of education in Lebanon to include statistics questions in all versions of the official exams in order to encourage K-12 teachers to put more effort on teaching statistics to students in their last

year. The students' attitude toward statistics may help instructors teaching statistics improve their performance and point out their weaknesses in giving the material, especially because almost all the instructors are either math or business majors (Skaf & Habib, 2008).

<center>Research Questions</center>

The research question in this study was posed as follows: *Do math scores on Lebanese admissions exams, students' scores on a quiz of basic mathematical skills and students' attitudes toward statistics have a relationship with students' final grades in business statistics courses?*

To be admitted into a university in Lebanon, a student has to pass one version of the official exam. Although, the math test is weighted the most in three versions of the exam, a student can still score poorly in the math section and pass the whole test if he/she achieves high scores on the other sections, because the scores of each section are simply added together to get a total score (school net Lebanon). One of those versions includes statistical questions while the others do not (school net Lebanon).

The purpose of the study is to answer three questions: (1) Do students' math scores in Lebanese admissions exams have a relationship with students' performance in statistics courses?; (2) Do students' attitudes toward statistics have a relationship with students' final scores in statistics courses?; and (3) Is there any difference in statistics course grades between students with high mathematical skills vs. students with low mathematical skills?

Because there are no math courses required to take statistics courses in Lebanon, a second factor affecting student performance is mathematical background. The study

investigated how much math students need to know in order to succeed in statistics courses, using a test of basic mathematical skills and its score effect on the final grade in the courses.

The third factor known from previous studies that affects student performance in general and specifically in statistics courses is students' attitude. The comparison of student attitude toward statistics between business statistics and biostatistics courses using Shau's survey was done for the first time in Lebanon.
Rephrasing all these questions in the form of a hypothesis, the researcher can state the alternative hypothesis as:

H_1: There is a significant relationship between students' scores on (1) the math part of the admissions exams; (2) on a simple mathematical skills test; (3)students' attitudes toward statistics; and (4) students' final grades in business statistics courses.
Independent variables:

Math scores, grades in the admissions exams, scores on the survey of attitude toward statistics (SATS), and scores on a math test with simple mathematical skills, gender and GPA.
Dependent Variables

Students' grades in the statistics courses.

<div align="center">Assumptions</div>

1.   It is assumed that participants in this study answered questions honestly and to the best of their abilities, also it is expected that they were able to answer all the questions in the survey within the time period suggested by the researcher.

2.   It is assumed also that instructors who entered the data on the provided excel sheets did their best to avoid mistakes and followed closely the solution key of the final exam prepared by the investigator.

Delimitations

1.   The study was limited to one university with seven campuses in Lebanon.

2.   Participants in this study were limited to those students who were enrolled in business statistics courses.

3.   The study was limited to the fall semester of 2011.

4.   One final exam was given to all participants and one answer key prepared by the investigator.

5.   Analysis of the data in this study can disaggregate Introductory Statistics from Intermediate Statistics as ancillary findings.

Definitions

1.   *Student Performance and student achievement in statistics courses* The forms and content of the statistics courses in Lebanon are approximately the same in most accredited universities. The term student performance in the statistics courses or student achievement refers to the final scores in the statistics course at the end of the semester.

2.   *Admissions exams in Lebanon* In Lebanon, primary education is usually from grade 1 to grade 6, lower secondary education is usually from grade 7 to grade 9, and upper secondary education (high school) is from grade 10 to grade 12 which is neither compulsory nor free (Ministry of Education (1997). There are two types of high schools – regular high school and vocational/technical high school.

Admissions to universities are conditional on passing one of the four sections of these exams; statistics questions are presented in one of these sections (Ministry of Education (1997).

3. *Attitude toward Statistics* In this study, the attitude toward statistics is defined as the attitude of students toward statistics materials taught in the introductory and advanced courses and measured by the instrument SATS.

4. *Grade point average* In this study, it is the grade point average (GPA) that the student achieved in the semester prior to his enrollment in the statistics course.

5. *Math skills* According to NCTM standards, acquiring mathematical skills require students to

    *   Perform arithmetic operations and reason and draw conclusions from numerical information;

    *   Translate problem situations into their symbolic representations and use those representations to solve problems;

    *   Develop a spatial and measurement sense;

    *   Demonstrate an understanding of the concept of function by several means (verbally, numerically, graphically, and symbolically) and incorporate it as a central theme into their use of mathematics;

    *   Use discrete mathematical algorithms and develop combinatorial abilities in order to solve problems of finite character and enumerate sets without direct counting;

    *   Analyze data and use probability and statistical models to make inferences about real-world situations; and

- Appreciate the deductive nature of mathematics as an identifying characteristic of the discipline; recognize the roles of definitions, axioms, and theorems; and identify and construct valid deductive arguments.

These are the same requirements in Lebanon, and in this study, mathematical skills were measured using a quiz of simple math operations (Ballard & Johnson, 2004).

Justification

This study had a threefold purpose. Firstly, it aimed to analyze attitudes toward statistics and their relationship with several individual determinants on the learning process. It presents a model for determining the relationship of individual factors and attitudes with student outcomes. These relationships were compared across seven university campuses throughout Lebanon. Thus, the outcome of this study can be used to provide a number of didactical recommendations for teaching statistics at Universities and Colleges, with a focus on making statistics memorable. The approach taken in this study is empirical-theoretical Sociology.

Secondly, this study aims to make a contribution to the development of statistical tools to analyze any changes in attitudes and provide tools to determine the influence of individual covariates on these changes in attitudes and, indirectly, on student outcomes. These results may contribute to the ongoing development and innovation of course material for statistics.

Thirdly, universities in Lebanon may change the requirements for statistics courses and set prerequisite math courses. The change of the requirement for statistics courses was done at Ball State University after a study that revealed the need for a change

in requirements by Green, Stone, Zegeye, & Charles (2007). Furthermore, this study may help the ministry of education in Lebanon to revise the admissions exams in order to fulfill the requirement of statistics courses in universities.

There is strong theoretical and empirical evidence that students' attitudes toward statistics directly influence the students' achievement (Carmona, 2005; Gal & Ginsburg, 1994). Specifically, unfavorable beliefs and attitudes, in this context, can result in negative learning outcomes, which are widespread among students of introductory statistics (Chance, DelMas, & Garfield, 2004; Delmas, Garfield, Ooms, & Chance, 2006; O'Connell, 2002; Saldanha & Thompson, 2001; Schafer & Ramsey, 2003; Schield, 2000; Verkoeijen, Imbos, Van de Wiel, Berger, & Schimdt, 2002).

However, there is a notable absence of empirical data on attitudes toward statistics and its relationship to students' performance in business statistics courses using the SATS instrument in the presence of other factors such as math skills and admissions scores. Literature has focused on students' attitudes and their relation to math skills (Carmona, 2005). Furthermore, other researchers have investigated the relationship between students' attitudes toward statistics and statistics anxiety with final performance of graduate students in statistics courses (Perepiczka, Chandler, and Becerra, 2011). The belief and attitudinal data referenced herein are primarily from the disciplines of physics, mathematics and science. In order to address this gap, this study developed and validated a multidimensional scale to measure students' attitudes toward statistics in business statistics courses with the presence of math skills, admissions math scores, GPA, and gender.

For the first time in Lebanon, students' attitudes toward statistics and their relationship to students' achievement was investigated. The results of this study may be the first step in a deep study of the complex relationship between attitude and performance of students in Lebanon and may encourage researchers in Lebanon to investigate more about this relation for a better understanding of the subject matter.

CHAPTER II

LITERATURE REVIEW

The review of literature includes three parts. The first part reviews the need for educational reform in statistics education, followed by the Expectancy Valued Theory and its relation to the study. The next two parts will review the empirical findings on general and specific determinants of student academic achievement. These parts will attempt to answer the following questions: What is missing from the literature? What will be learned from putting the literature review together? What are the theories which are supported by the literature? What questions does the literature review suggest/generate?

The Need for Educational Reform

In recent years, statistics educators have been very concerned about the pedagogical strategies and traditional curricular materials used in statistics courses that have not been effective in developing conceptual understanding of statistics topics (Cobb, 1992; Gal, 2003). Traditional approaches were also found by many researchers to play a rather limited role in improving statistical reasoning abilities and promoting statistical literacy among students (Garfield et al., 2002; Hassad, 2008; Moore, 2007).

Growing frustration and dissatisfaction experienced by students and faculty with statistics courses over the years has led researchers to investigate reasons for this lack of understanding of the material. At the heart of statistics education reform lies the question of how the teaching and learning of statistics can be improved. The reform movement over the past decade has supported efforts to transform teaching practices to include an emphasis on students' development of conceptual understanding rather than a sole focus on mechanical calculations (Chance & Garfield, 2002). The traditional methods of learning are either students passively listening to lectures or working in isolation. These

methods have been identified as leading causes for statistics and mathematics to be viewed as a sequence of disjointed topics padded with a series of techniques and rote memorization of fragmented facts (Begg, 2004).

The development of Introductory courses in statistics in the United States can be divided into roughly two periods, one during the first half of the twentieth century with large groups of students using classic books such as Snedecor's from 1937 Statistical Methods. The second episode starts toward the end of the twentieth century with small groups and active learning processes. During the first period, students were assumed to be quantitatively skilled, but in the 1960s the ideas about teaching statistics courses began to change. First of all data analysis became a more independent scientific activity, and second a number of suitable analytical tools were introduced and students no longer had to spend hours behind a mechanical calculator (Aliage et al., 2005).

Toward the end of the seventies, the era of the modern statistics courses begins (Aliage et al., 2005). The growth in enrollment, the introduction of placement tests and the publication of two statistics books by Freedman (1978) and Moore (1985), made a change in the way of teaching statistics courses. The importance of being able to understand and interpret statistical output increased which led to greater emphasis on statistical applications. The number of requirements for introductory courses in statistics rose, since the importance of being able to understand and interpret statistical output increased over the years. This also resulted in a shift from a highly motivated and quantitatively skilled student population to a population of students who only took the course in order to meet the departmental requirements. Furthermore, the latter students were not quantitatively skilled. The article published by Cobb in 1992 recommended that

the statistical curriculum should change to emphasize statistical thinking (Bryce, 2005).

This article was seen as the main driving force behind the changes in statistics courses, as Cobbs suggested the use of fewer formulas, reliance on more automatic computations, real-life data analysis and greater use of active learning tools instead of lecturing. His suggestions started a major change in statistics education.

In 2001, the American Statistical Association launched a set of curriculum guidelines that emphasized a constructivist way of looking at statistics courses. The guidelines were meant for undergraduate programs at universities and colleges, especially for students who major in statistics. These guidelines distinguished between mathematics and statistics, as statistics is considered to be a more practical education in statistical reasoning. Besides a number of skills (e.g. computer skills, to a certain extent mathematical skills, and statistical skills), students have to master more general academic skills such as writing, doing team projects, and presenting. Furthermore, students also have to master a few methodological skills (research skills) in the field of study (Am Stat, 2001). As these guidelines have been developed for students who major in statistics, they will not be further discussed, because this is beyond the scope of the subject of this study.

The introduction of statistics courses in Lebanon began in late seventies (Skaff & Habib, 2008). Universities consider mastery of statistics to be part of essential academic skills. These skills involve the mastery of research processes such as the collection and analysis of data, interpretation of results and presentation of results and conclusions. According to the content of statistics courses in Lebanon's universities, students learn to think and learn to communicate within these introductory courses (Skaff & Habib, 2008). They learn how to develop a research question and a research plan and, most of all; they

learn how to analyze quantitative data. Most of the course objectives are driven by learning to think, but part of the course is also based on learning how to communicate, as students have to present exercises and reports and work together in groups. Lebanese students find these courses very hard; in this study the researcher will investigate the relationship between several factors and students' performance.

<div align="center">Expectancy Value Theory and Attitudes Toward Statistics Courses</div>

The Expectancy Value Theory (EVT) is a model for explaining achievement related choices (Wigfield et al., 2004). The development of EVT started in the 1930's by Lewin and Tolman, and the general model was developed by Atkinson and Feather (Wigfield et al., 2004). This theory has many applications in predicting achievement-like behavior, similar to learning behavior. According to the basic theory, achievement behavior can be looked upon as a function of the expectancies a student has, the goals toward which he/she is working and the task value of the student. When the student has more than one choice, he or she will choose the option with the best possible combination of expected success and value. In other words, one can look at this model as a form of rational choice (Schunk et al., 2008). In turn, the students' motivations and beliefs are influenced by cognitive processes, such as experiences with past events and perceptions of expectations of others. Lastly, these processes are linked to previous events, upbringing and cultural stereotypes.

Next, EVT will be applied to Attitudes in Statistics Education. This application is based on the notions developed by Wigfield, Tonks, and Eccles (2004); the researcher will explain how the model can be linked to attitudes toward statistics.

<div align="center">Applying the Expectancy-Value Model to Statistics Attitudes</div>

Student achievement in statistics is assumed to be linked to the perception of being successful in the course. In other words, if students perceive their ability to be successful in statistics positively, they will have higher expectations and values toward their achievement, and they will be better motivated to work hard. What the researcher needs to know is the students' perception of their ability to do statistics (cognitive competence) and their perception of difficulty of the statistics tasks and their feelings toward the course (more positive experiences result in more positive feelings about the course). Furthermore, the researcher needs to know what task value students attach to the task before them. The model predicts expected achievement (student outcomes as part of course outcomes) using four types of attitudes toward a task/course, such as affective feelings, perception of difficulty, cognitive competency and task value. They will be elaborated below. These attitudes derive from the motive for success and the motive to avoid failure, and from the evaluation of the success rate in a given situation.

As the motive to be successful derives from experiences in achieving success in a previous learning situation (such as in high school mathematics), the motive to avoid failure derives from similar learning situations where the student was unsuccessful. Experiences of success result in high achievement motivation, and a lack of success results in motives to avoid failure (Motivation, 2006). In turn, these motives are shaped by the interpretation of previous experiences and the expectancies of the social surroundings (peer pressure, expectation and socialization). Lastly, society plays an important role in affecting those beliefs and motives. In 1995, Schau applied EVT to attitudes toward statistics (Schunk et al., 2008; Sorge & Schau, 2002; Wigfield & Eccles, 2000); the model predicted the influence of expectancy and value factors on student

achievement. Schau (1995) proposed a model for predicting student outcomes using institutional, student and course factors (Garfield, 2003). Although student learning is considered the main predictor for achievement, a positive attitude toward statistics is also considered to be a major determinant of course outcomes (Hilton, Schau, & Olsen, 2004). Shau's model shows both direct and indirect effects.

Development of Attitudes Toward Statistics

For the development of the Survey of Attitudes Toward Statistics, Schau, Stevens, Dauphinee, and DelVecchio (1995) formed a panel of experts (both students and instructors). All members had expertise in enrolling in or teaching statistics courses. During a mind mapping session they came up with a number of words and concepts that could best describe attitudes toward statistics. They also reviewed previous measurement instruments for proper descriptions of attitudes toward statistics, as follows:

1. Difficulty of the tasks, i.e. perceived difficulty for a particular student

2. Cognitive competence, i.e. students' perceptions of whether or not they mastered the necessary knowledge and skills

3. Affect, i.e. the students' positive and negative feelings about the course It is believed that students' affect toward statistics is important in its own right (Sorge & Schau, 2002).

4. Value, i.e. students' individual motives and beliefs about the importance of fulfilling a task (the usefulness for one's future job, intrinsic interest in the task and whether the cost balances the effort). This component, also known as Task Value, was added for two reasons:

• Student's affective feelings toward statistics may not be the same as their attitudes about the value of statistics.

• Valuing statistics may result in statistics anxiety. Besides the aforementioned attitudes, Schau added two more components at a later stage of the development of this model (Schau, 2005):

5.   Effort, the effort a student plans to put in, in order to achieve a good grade.

6.   Interest, the students' level of individual interest in statistics (Schau, 2003).

The application for this study

For the model in this study elements from both Prosser and Trigwell (1999), and from the Schau (1995) model will be used. In this model it is assumed that attitudes toward statistics reflect upon a certain learning motivation. In that sense, attitudes influence student outcomes. Individual characteristics, such as previous math experience, self confidence and background, and educational characteristics, such as didactical and assessment methods, in turn influence these attitudes and, indirectly, outcomes. Attitudes toward statistics obviously already exist before any course starts. As a result of taking a statistics course, this attitude could change. The researcher is interested in the effect of attitude on students' final grades. Therefore, the choice has been made to measure these attitudes at the end of the course, and then to analyze its effect on their final grades. A more detailed description of this method will be given in Chapter III.

The student attitude toward statistics has been widely studied. It affects the extent to which students will develop useful statistical thinking to be applied outside the classroom. Important work done by several researchers (Shau, Stevens, Dauphinee, &

Del Vecchio, 1995; Wise, 1985) involved the use of two instruments, the questionnaire

known as Attitude Toward Statistics (ATS) (Wise, 1985) and the Survey of Attitudes

Toward Statistics (SATS) (Shau et al., 1995). The ATS used 29 items to measure

attitudes in two areas. The *field* scale (20 items) aimed to measure a student's beliefs

about the value of learning statistics and the use of statistics in his or her chosen field of

study. The *course* scale (9 items) aimed to measure affect associated with learning

statistics and attitudes toward the course in which a student is enrolled. In this study, the

researcher used Shau's recently updated questionnaire; the survey's three sources for

attitudes and beliefs were: First, students bring with them their unsuccessful experience

with statistics from previous experience in school-related contexts. This experience could

have occurred through reading or doing research that uses statistics. The second is the

understanding of statistics based on outside lives. The third possible source is that

students believe statistics is mathematics and so their attitudes toward mathematics are

merely transferred to statistics (Schau et al., 1995).

Empirical Findings on the Determinants of Student Academic Achievement

Literature documented several variables to be general predictors of success in

business, mathematics, and science courses. One variable is cognitive: students'

quantitative and analytical skills. Standardized tests such as the mathematics sections of

the ACT or the SAT, and local tests that contain neo-Piagetian questions and questions

focused on course-specific logical skills, provide data relevant to this variable. Data from

such tests are easily generated or acquired and readily interpretable.

A second general variable that predicts success is affective, and relates mostly to

students' academic self-esteem. Measures of academic self-esteem are not as widely

available as measures of mathematical skills, but numerous instruments are available for measuring this variable. The results these instruments yield, however, might not be as easily interpretable as results from a mathematics test. Mathematics tests typically contain questions that have correct or incorrect answers, whereas instruments that measure student affection typically generate graded responses. Furthermore, student affection can vary from course to course, teacher to teacher, even day to day. Still, reliable and valid methods of measuring student affection, including academic self-esteem, exist.

The third nearly universal variable that predicts student success in business, mathematics, and science courses is grade point average (GPA). GPA is neither a cognitive nor affective variable; it is neither a measure of aptitude nor state of mind. Instead, it is a measure of performance. Both cognitive and affective states influence it. Similar to data on mathematical skills, data on students' grade GPAs are widely available. But the interpretation of students' GPAs is potentially more challenging, since GPAs are a composite measure of a student's overall high school experience. In this study the GPA studied was the GPA of the semester before taking the statistics course or the high school average if statistics was taken the first semester of college.

In addition to these nearly universal predictors, several subject-specific predictors are documented by multiple researchers. The value of attribution to success in computer science is well demonstrated, and might be an affective characteristic related to academic self-esteem. Hands-on experience with computers, both before college and in class also seems to enhance a student's chances of success in this field. These factors may have influence on statistics achievement since it is required for students to have statistical

software homework. However, this factor was not studied in this dissertation because it would not be a part of their final grade.

Experience also seems to be valuable for success in other fields of science. In physics, prior experience with complex physical concepts and theories seems at least as valuable as hands-on experience with physical phenomena. The same has been shown to be true in biology. This could be true because most university-level science courses require students to grasp concepts associated with post-formal operational reasoning, and time, intellectual maturity, and experience are all required for post-formal concept construction (Lawson, Drake, Johnson, Kwon, & Scarpone, 2000a; Lawson, Alkhoury, Benford, Clark, & Falconer, 2000b). If this were true, then one would expect that experience also plays an important role for success in chemistry. However, the effect of experience on success in chemistry has not yet been thoroughly investigated.

The finding that academic experience can have a negative effect on student success in economics and finance courses is interesting and not well explained. It is possible that the concepts that are introduced in community college economics and finance courses are different than – or even in conflict with – concepts introduced in economics and finance courses at the university level. It is also possible that university level economics and finance courses are more tailored for students who intend to continue their educations in these fields, whereas courses at the community college level are tailored for people who do not plan to continue. Educational content of courses and pedagogy could therefore be different at the two kinds of institutions, and students with experience at the community college level might have a different perception of requirements for success in these courses than students at the university level.

Although most studies to date have described what seem to be legitimate predictors of success in introductory college business, mathematics, and science courses, these results must be interpreted with caution. All published studies reviewed for this dissertation aspired to find predictors of success in business statistics courses, and all studies successfully found them. However, few of the studies were actually experimental; most protocols involved *post hoc* comparisons of student grades with other variables. Thus, the results of most studies are correlative, not causal. Factors that ostensibly cause student success in business, mathematics, and science courses – i.e. factors that cause the reported correlations to exist – could be different than those reported in the predictive studies.

For example, numerous authors report that scores on exams that measure quantitative and analytical skills correlate strongly with final grades in business, mathematics, and science courses. What causes a student to receive a high (or, alternatively, low) grade on an exam that putatively measures quantitative and analytical skills? One obvious possibility is student aptitude. Other possibilities might include the career choices or education level of the student's parents, who could be mentoring the student in this area of achievement. Or perhaps high scores on exams that measure quantitative and analytical skills were driven by access to educational resources and opportunities, such as attendance at a summer math camp, or participation in an extracurricular test preparation course. Access to such resources might ultimately be determined by the student's socioeconomic circumstances. These circumstances could be a causal factor driving the student's final exam score.

Related to academic self-esteem, student attitude also influences performance in science classrooms. Students with more positive attitudes toward science tend to do better in science courses (Weinburgh 2000). Females typically have more negative attitudes toward science than do their male peers (Bailey, 1993). This effect was studied in this dissertation.

Another example of a result that might be challenging to interpret is the finding that a student's academic self-esteem correlates strongly with her or his final grade. Students with high academic self-esteem tend to do well in business, mathematics, and science courses. But what causes a student to have high academic self-esteem? Intrinsic confidence in one's own intellectual abilities is an obvious possibility. But intrinsic self-confidence in college science is not equivalent among females and males. Females tend to perceive their cognitive styles as imaginative and intuitive, and inconsistent with the rote, serious, and competitive culture of most college science classrooms. Females also raise their hands and manipulate laboratory equipment less frequently, and prefer to work in groups more frequently, than do males (Tobin & Garnett 1987). Forms of engagement that are preferred by females might be discouraged in college science classrooms and labs and contribute to the discomfort of female students. Using engagement techniques that are discouraged in the classroom or have the perception of being out of place in the classroom could affect a female student's level of comfort (Wilson, 2002) or belief in her ability to succeed (Brush, 1991).

In addition to intrinsic factors, extrinsic factors might also affect a student's academic self-esteem. Again using gender as an example, females and males often respond to pedagogical styles and classroom cultures differently. Many females prefer

and are more comfortable in classrooms where deliberation and collaboration are more common than memorization and competitiveness (Tobias 1990). Most introductory business, mathematics, and science courses have classroom cultures that alienate instead of encourage female students (Constantanople, Cornelius, & Grey, 1988). In science classrooms, males are engaged more by teachers (Tobin & Garnett, 1987), and male role models – including the professor and teaching assistants – are more common than female role models (Brush 1991). Such pedagogical and cultural inequities can have significant negative effects on the academic self-esteem of female business, mathematics, and science students.

More empirical analysis on the determinants of student academic achievement includes university effects, students' own characteristics, family background, and community. Before the discussion of university effects, one should first distinguish between university's effects and effects of enrolling in a university. The latter is the influence on the achievement of being enrolled versus not being enrolled in university, while the research on the former examines the variation of the level of resources, policies, or university climate. These variations explain achievement differences among students (Baker & LeTendre, 2005). These factors were not studied in this dissertation, because Lebanon has different university regulations and societal expectations than other countries.

Empirical Findings on the Dissertation Specific Determinants of Student Academic

Achievement

"Education remains the most effective defense against underdevelopment and poverty" (McKinnon, 2007, 35). Although education is not a magical tool for creating a

perfect world, it aims at reducing the degrees of inequality and war (Delors, 1996). In short, through education, we learn to live together (Delors, 1996).

First, the researcher will present the history of war and its effect on higher education in Lebanon, with a background of the attitudes of families in Lebanon toward higher education. This way, the reader can have a better understanding of the education in Lebanon that continues to be regarded as an essential tool for development (United Nation report, 2009).

The recent history of Lebanon has been characterized by religious and political tensions including a civil war from 1975 to 1989 and severe internal political tensions after the assassination of the first prime minister, Rafik Hariri, in February 2005. Several studies have been conducted to reflect the history of education in Lebanon, and there is a continuous desire of families to seek higher education for their children in order to achieve a better future (United Nation report, 2009). Abboud in 1998 represented the history of education in Lebanon, which has forty-one nationally accredited universities, several of which are internationally recognized. Most of the families in Lebanon put great importance on higher education due to cultural and social reasons. Almost every family has at least one child graduating from a university, and the rest will have a high school degree which is known as *Baccalaureate*. If students fail the Baccalaureate exam (stated in this study as the university admissions exam), they are willing to repeat it more than two times until they pass it (Abboud 1998).

This study built on Lebanese students' skills attained from high schools by using their Baccalaureate official grade on the math section from the ministry and tested its influence on final grades in statistics courses.

Another study presented the different sections of the admissions exams in Lebanon called *concentrations* where students planning to go to the sciences majors, either opt to take the *Life Science* concentration or the *General Sciences* concentration of the exam, and students planning to go to social science majors take the other two versions *Sociology and Economic* and *Humanities* with an emphasis on *Sociology and Economic* for business and economics majors. On the admissions test in each concentration, subjects that fall out of the concentration are given less weight in grading and are less rigorous, while subjects that fall within the concentration are more challenging and contribute significantly to the final grade. Although the study pointed out that the university admissions exams, or the *Baccalaureate*, taken by students at the end of grade 12 is prepared by highly qualified teachers continuously enrolled in workshops prepared by the ministry, a lot of criticism is made each year after the results of the exams have been published. The Lebanese National Center for Educational Research checks the validity and reliability of those exams every few years (Abboud, 1998). This study is the first study to investigate the relationship between the admissions exam grades and the students' grades on the business statistics courses taken in universities in Lebanon.

A large body of research has investigated the prerequisites needed to succeed in statistics courses; one of those studies succeeded to change the prerequisites of statistics courses. The authors demonstrated that requiring a sequence of math courses that contain more credit hours as prerequisites for statistics courses, increases the probability that a student will earn a better grade in business statistics (Green et al., 2007). This study is important to encourage other universities to take into consideration the prerequisite courses needed to succeed in business and economics courses. In a study that was

conducted from Fall 2001 until Summer 2006, the researchers changed the prerequisite sequence of math courses and asked students to take another sequence of math courses that included more calculus than algebra. The binary probit model assessing the impact of several changes reflected an improvement in the grades of students in statistics courses. Although this study will help universities build the sequences needed for statistics and economics courses, it may be limited to the content of the math courses in the sequence, because not all universities have the same content material in the courses taken. Also there could be more factors other than including calculus that affect students' performance; one example is algebra anxiety as it is known that students in college prefer calculus over algebra. The current study was built on these results to encourage universities in Lebanon to re-assess the effectiveness of the prerequisite math courses that their students are required to take.

Other research investigated other factors affecting performance of students in statistics courses. Mathematical skills were tested to check their effect on scores in micro-economic courses (Ballard & Johnson, 2004) and business statistics courses (Johnson & Kuennen, 2006). Both studies proved that basic math skills are needed to succeed in statistics courses; they tested the following four factors affecting student performance: (1) the student's score on the mathematics portion or science portion of the ACT assessment test; (2) whether the student had taken calculus or business calculus; (3) whether the student had been required to take remedial mathematics; and (4) the student's score on a test of very basic mathematical concepts.

Both studies were done on a sample of 300 students enrolled in business statistics courses and 1400 students in micro-economics courses within two semesters in two big

universities. Similar results were found in both studies: only basic mathematical skills are important to succeed in statistics courses; students with high GPAs are more likely to achieve better grades than students with low GPAs. The only difference between the two studies is that the ACT math score was related to high scores in micro-economics courses but had no effect on business statistics scores that were found to be related with scores on ACT science score. Other factors that also have an effect on statistics grades are gender and GPA.

The results of those studies were consistent and reliable; the test of math skills was studied to check its validity and reliability and none of the questions were omitted. Statistics is considered by most of the students as well as teachers a difficult subject to teach and learn (Yilmaz, 1996). Elements of data analysis and probability are being emphasized in all statistics courses. The content of those courses are divided into descriptive statistics which requires formula manipulations in which students' high achievement may be due to their knowledge of algebra (Galagedera, 1998) and inference which requires the use of probability concepts in which no algebra is needed, but more logic, intuition and previous knowledge of set theory. This means that some mathematical knowledge is needed in statistics courses. According to Ben-Zvi (2000), statistics is considered as a liberal art which involves critical thinking and separating sense from nonsense. Therefore, effective use of statistics requires the ability to synthesize, interpret various components and analyze into a whole (Vaisanen, Rautopuro, & Sakari, 2004).

Statistics is an important element of the curriculum in higher education, although students in social sciences believe that taking a statistics course is just an obstacle that they need to confront in order to finish their degree. They forget that they need to

understand statistics for a better achievement in applied projects such as master's theses or dissertations. Also, they mistakenly think that doing qualitative research will avoid the need for prior math knowledge.

Therefore the need for prior math knowledge is crucial, but how much math students need to succeed in statistics courses was studied in this research. Indeed, is it simply more advanced mathematical knowledge?

In the last several years, the philosophies of teaching and practicing statistics have changed from heavily mathematical calculations and the ability of students to derive particular statistical formulas to practical statistics. In addition, new text books focus on the analysis and interpretations of real datasets, situational problems, real cases and the understanding of statistical concepts in order to apply them instead of deriving them mathematically (Cobb, 1992; Khamis, 1991; Nolan & Speed, 1999; Rossman, 1996; Royse & Rompf, 1992; Watts & Carlson, 1999).

In addition, the recent introduction of computer software in teaching statistics courses reduces the need for heavy calculations and focuses only on interpretations of the data and finding results using software. Although this makes the lack of mathematical background less important, it requires students to know technology and introduces computer anxiety. This study did not investigate the use of technologies in teaching statistics because the emphasis was on other factors affecting student performance.

Students' difficulties with statistics and quantitative methods have been repeatedly documented in different fields of study, such as education (Lehtinen & Rui 1995), psychology (Hauff & Fogarty, 1996) and even biology (Kelly, 1992).The roots of these difficulties in universities appear in high schools (Post, Medhannie, & Harwell,

2010); this is the reason for investigating students' math scores in Lebanese admissions exams. In general, prior achievement in one subject affects students' motivation, interest and engagement in studying; yet, this assumption needs to be further specified.

These studies can be a good reference for the present study where the researcher tested approximately the same factors to check their relation with scores in statistics courses, with a difference in the sample studied. Students in the USA need math courses as prerequisites for statistics courses which is not the case in Lebanon, where students can enroll in statistics courses in the first semester of their studies. The researcher tested their math skills by checking their scores on admissions exams and used the same test from these two studies to test the basic mathematical skills.

The results of the above studies were similar in a way to another study done in New Zealand by Harraway (2002), who tested the previous statistics and calculus knowledge and its effect on students' achievement in biostatistics courses. The researcher found that there was no need to know statistics to achieve high scores but previous knowledge of calculus was beneficial.

The impact of prior mathematics achievement on students' performance was also studied in another area of interest. A study done by authors coming from three universities studied the impact of the mathematics curriculum in high schools on mathematics performance of students in universities. A very large sample of students divided into three strata was studied; their ACT mathematics scores were the main variable studied. The three strata were students who completed three or more years of a developed curriculum, the National Science foundation-funded curriculum or the University of Chicago School Mathematics Project curriculum (Post et al., 2010).

It was found that there was no relationship between high school curricula and the number of college mathematics courses completed. Also, high school curriculum was not differentially related to the pattern of mathematics grades that students earned over time or to the difficulty levels of the students' mathematics course-taking patterns. This study had limitations because those curricula studied are not used across the states to predict consistency and reliability of these results. Although the sample was large (4,144 from 266 high schools) and the students were enrolled in a large, research-oriented public university with relatively high entrance standards, the findings cannot automatically be generalized to students in colleges or universities varying in mission, size, or selectivity.

In addition, since the ACT mathematics scores were the variable studied as a measure of prior mathematics achievement, the researcher feared that the curriculum studied might have been confounded with ACT scores. In this study, a similar approach was used, but the variable studied was students' scores on Lebanese admissions exams since ACT or SAT exams are not a requirement to enroll in universities, except American universities. The unique approach was to investigate the impact of math scores on the admissions exams in Lebanon on students' statistics scores.

Most of the studies about students' performances were done in the USA and Europe. One study in UAE done by Harb and El-Shaarawi (2006) took into account cultural differences that may shape the factors that affect students' performance. Those two authors ran their study in a university in UAE and found that the factors affecting performance were being weak in English and missing class lectures. The study investigated the socio-economic characteristics of students of the college of business by taking into account variables pertaining to the Arab society.

The regression model used included many variables but only English competence and class participation were found to be positively correlated with students' performance. Also, it was found that non-national students outperformed national students and female students outperformed male students. Several limitations of this study can be detected. The restrictions on female students and their presence in a separate campus could have given a lack of competition between males and females, which led to a deep comparison between their performances. Also, the pressure on non-national students who pay very high tuition compared to national students was not taken into consideration by the authors of the article. The cultural background of Lebanese students is different from those of UAE students, for Lebanese people have a strong knowledge of English, and campuses of universities are not separated according to gender. Gender was studied in this research and it may be good to find if there are similar results concerning gender between Lebanon and UAE.

No effect of gender was found in the study done by Harraway (2002) in New Zealand on students' scores in biostatistics courses. But in the study done by Johnson and Kuennen (2004), it was reported that females did better than males in statistics courses. This result needs to be investigated more because other studies revealed that males achieve better grades than females in sciences and applied courses as reported by the National Assessment of Educational Progress (NAEP); Freeman in 2004 also reported that males continue to outperform women in fields such as mathematics, sciences, finance and economics. This is not the case in statistics, in which women comprise a higher proportion of undergraduate majors and degree earners than in mathematics, engineering, or economics (Scheaffer & Stasny, 2004).

The effect of gender on students' performance is still considered very interesting to researchers. Studies reported that students taught by a professor of the opposite sex achieve significantly lower scores than students taught by a professor of the same gender (Haley et al., 2007).This significant result was tested in this study after controlling for mathematical skills.

Literature reviewed another factor that may affect students' performance in statistics courses: students' attitudes toward statistics. It was demonstrated that this factor is as important as other factors like previous math skills, or scores on ACT exam in the mathematics and science sections.

The fear of taking statistics courses was heard by most advisors. In fact students only take statistics because it is required, and it is considered a major obstacle toward the attainment of the desired degree. A study done in Saudi Arabia at Umm Al Qura University (UQU) stated that graduate students become anxious when they attend the first statistical course and, when possible, attempt to delay taking the required statistics courses until just before the end of their program. This study done by Asseri and Aldogan in 2003 examined the effect of non-cognitive factors on the variation of students' academic achievement, such as students' feelings, attitudes, beliefs, interests, expectations and motivations. In order to achieve their goal, the authors translated Wise's instrument to the Arabic language. The translation was reviewed by a number of specialists in English and Arabic. The final form of the instrument in Arabic contained, in addition to Wise's twenty-nine items, nine new items, and the validity of the test was examined on one hundred and seventy-eight (178) graduate students who participated in

the study and were enrolled in an introductory course in statistics at two large universities in Saudi Arabia.

The study reported findings concerning the reliability and validity of the instrument with the semantics differential attitude scale. The factor analysis result confirmed the presence of two factors somewhat similar to what has been confirmed in the previous research. The instrument in this study was not be translated into Arabic because Lebanese students have fewer problems with the English language compared to students in Saudi Arabia, but the research might have obtained similar results concerning non-cognitive factors measured by this instrument. Asseri and Aldogan's study may help our study by highlighting the social background of Arabic people since this study dealt with almost the same social environment.

Perney and Ravid in 1991 stated: "Statistics courses are viewed by most college students as an obstacle standing in the way of attaining their desired degree. It is not uncommon to see students who delay taking the statistics courses until just before graduation. . . College professors who teach the research and statistics course are all too familiar with the high level of anxiety exhibited by the students on the first day of the term" (Perney & Ravid, 1991, 33). Almost all statistics educators reported that students enroll in statistics courses with a negative attitude toward learning statistics.

A study discussing instruments used to measure the attitude toward statistics was done by Gal and Ginsburg in 1994. They first discussed problems teachers may have at the beginning of each statistics course related to students' attitudes toward statistics before enrolling in statistics courses; educators are often worried about how much motivation they can succeed to boost in students. Moreover, they discussed the

weaknesses of the instruments used to measure attitudes toward statistics. In their introduction, they discussed problems that educators may confront in statistics which are the outcome they desire to achieve and the educational process. In general, statistics courses, especially the first course, have several goals: they relate statistical data to students' field of study like biology, business, and education to prepare students for professional careers; teach students how to interpret data to relate students' personal lives to statistical aspects or interpret data in newspapers or televisions; and finally prepare the students for more advanced courses in statistics in order to achieve a high level of knowledge to do research studies or prepare students who may major in statistics.

Gal and Ginsburg in 1994 also discussed what statistics courses should reveal to students, and what material should be included in more advanced statistics courses. This means that a teacher should relate statistics courses to each student's field of study, in a way that students will finish the course with a positive feeling about statistics and feel its potential use in their professional areas. In addition, the authors pointed out that statistics courses should help facilitate problematic thinking in their daily lives. They should think statistically in authentic situations. Students should not leave statistics classes with a feeling that statistics is not relevant to their life.

As a summary of Gal and Ginsburg's (1994) important discussion, the authors emphasized several important points: (1) motivation for further learning; (2) willingness to think statistically; (3) confidence regarding statistical skills; and finally (4) understanding and positive regard of the relevance of statistics in students' personal and vocational lives.

The other problem Gal and Ginsburg (1994) discussed was the teaching process. Many educators have problems in constructing a statistical course; they fear missing any goals needed in statistics education. One of those goals is developing flexible problem solving and data analyzing skills (Moore, 1992). The authors explained developing a problem solving environment for learning statistics by building a supportive atmosphere where students feel safe to explore and brainstorm, by different statistical tools.

Math anxiety was also mentioned by Gal and Ginsburg in 1994. Indeed, students may carry this anxiety with them to statistics classes. Beliefs and attitudes toward math may play a powerful role in affective responses to statistics (McLeod 1992) as well as their beliefs about the relevance of statistics for their future career or job plans. The last point discussed by the authors was the frustration of students when experiencing difficulties with their statistical studies. They become bored or disinterested. Allan and Lord in 1991 suggested a sequence of events triggered when students experience an initial failure to understand. It is well known that confusion leads to failure to receive assistance from the teacher, which leads to a loss of confidence and panic about failure.

The study of Gal and Ginsburg 91994), discussed above, was done to review the role of attitudes in the learning of statistics. The authors presented a deep discussion about this role, and they criticized the instruments for assessing attitudes and beliefs of students. The researcher used the newest version of SATS updated by Shau in 2004. After the publication of this instrument, most researchers began to use it. It contains more than two scales which reveal a better understanding of students' attitudes toward statistics.

Another study done by Carmona in 2005 used three instruments to measure the attitude toward statistics: the Survey of Attitudes Toward Statistics –SATS- (Schau et al., 1995), the Attitudes Toward Statistics scale –ATS- (Wise, 1985) and the Statistics Attitude Survey –SAS- (Roberts & Bilderback, 1980). The first two instruments were discussed above. The SAS is an instrument consisting of 33 items. The SAS is proposed as a one-dimensional scale, so that "*it was not assumed that the SAS was factorially complex or that there were useful possibilities for identifying subscales for diagnostic purposes*" (Roberts & Reese, 1987, 759).

The study tested two factors related to a math background that have been shown to be related to attitudes toward statistics in previous research: (a) the more or less math-oriented secondary education (Gil, 1999); and (b) math grades obtained in secondary education (Sorge & Schau, 2002). The purpose of the study was to explore which subscales in the three instruments used have a strong association with a math background.

The results of the study suggested that a mathematical background has a strong association with the affective responses to statistics, especially the attitudes toward the statistics course, rather than with the value of statistics. The study also found a weak relationship between a math background and the attitudes about usefulness of statistics (SATS-Value and ATS-Field). In this point Carmona's study was in agreement with Gal and Ginsburg (1994, 37-51.) when they stated that "a student's responses to items assessing usefulness-of-statistics issues might have little to do with feelings or attitudes toward statistics as a subject; instead, they may only reflect the student's vocational development or knowledge about requirements or content of certain jobs".

This study explored the relation between attitudes toward statistics and students' grades in statistic courses; it may build on the study above to compare their results with what was attained. Carmona in his study only explored students' mathematical backgrounds, but other factors may affect students' attitudes toward statistics which were investigated in this study. In addition, the measure of mathematical background was not clearly discussed in the methodology section, as done by other studies mentioned earlier.

A study in Taiwan done by Luh, Guo, and Wisenbaker in 2004 compared the attitude toward math and the attitude toward statistics using two instruments. The first was the Mathematics Attitude Scale which has 10 items, using a likert scale from 1 (strongly disagree) to 7 (strongly agree); the higher the score was the more positive attitude toward mathematics. The second is the SATS. The study compared attitudes toward statistics and toward mathematics between college students and cadets in Taiwan. The cadets were students in the air force of Taiwan. The results of the study showed that both groups had positive attitudes toward statistics. In addition to that, the college students had higher perceived math ability and math attitude but lower Cog Comp scores than the cadets. The distinguished difference between the two groups was the Cog Comp subscale. There was a negative relation between Cog Comp and math attitude for the college students, and positive relation for the cadets. The importance of this study is the results revealing the lower attitude of college students in Cog Comp sub score and the higher math ability the college students have. This is surprising since the cadets enrolled in the air force program usually have higher math ability than other students. This study may help to change the perception that having high math skills does not mean that students will have a positive attitude toward math or statistics. The implication of the

results is that teachers must enhance the perception of the cognitive competence for college students while teaching.

The literature talked about the attitude toward statistics and its impact on students' performance. One literature review focused on factors affecting students' performance in undergraduate statistics courses for the social sciences. It presented a review of literature about statistics anxiety and attitudes linked to students' performance in statistics classes. Math factors have also been reviewed such as anxiety and attitude, but the authors found that the relation has not been clear. Concerning the review of computer anxiety, the authors have found that results from other studies showed that computer experience will not reduce the anxiety and improve the attitude for some students unless it is positive.

The authors defined in their literature review statistics anxiety as a type of performance anxiety defined by worry, physiological arousal, and mental disorganization (Zeidner, 1991).They also defined the statistics attitude as it consists of two facets. The first facet was attitude toward the course, and the second facet was the attitude toward the usefulness of statistics in their field (Wise, 1985). The study also discussed computer anxiety. They used the Computer Attitude Scale (CAS) which had three subscales: anxiety, liking, and confidence (Loyd & Gressard, 1984). The study was helpful in reviewing what other researchers did in linking statistics attitudes to students' performance. The authors recommended, for future research, the link of gender identity with the students' performance, which is one of the factors that were measured in this study.

Lalonde and Gardner (1993) worked on all the three classes measured by other researchers, aptitude, anxiety and attitude, and found that they were correlated with the

performance of psychology majors. The authors contradicted the results found earlier by Labre and Suarez (1985) that math anxiety has no relation with the performance of a student when they enroll in math courses. The study of Lalonde and Gardner (1993) revealed that math anxiety still makes a difference on scores in statistics courses because of its effect on different attitudes and motivation, which have an impact on the amount of effort the student exerts in learning statistics. The study results also found a negative relationship between statistics anxiety and aptitude in the context of learning statistics. The method used in this study consisted of two samples taken within two semesters and a questionnaire which was distributed to students that contained questions about anxiety and attitude measures, followed by a math test and demographic questions. The measured variables were mathematical background, basic mathematical ability, number anxiety, statistical anxiety, attitudes toward statistics in psychology, attitude toward learning statistics, motivational intensity, statistics course evaluation, statistics instructor evaluation, assignments, quizzes, first and second term exams, then final grades. The test reliability was measured and revealed a high reliability suggesting that this type of measure of anxiety was stable across time and well developed.

The results of Lalonde and Gardner revealed a relationship between the anxiety and performance measures, similar to the relationship between mathematical aptitude and performance measures, but the measures of number and statistics anxiety were negatively correlated with exam performance in both the first and second term exams. Another interesting finding in this study was that the attitude and motivation measures with performance were significantly correlated with the number of assignments completed, but

students' attitudes about learning statistics were marginally correlated with the number of completed assignments.

Lalonde and Gardner's (1993) results pointed out several important variables that may affect students' performance in statistics courses. The researcher measured some of those variables in addition to other variables in order to help students and teachers in their process of teaching and learning. The study of Lalonde and Gardner (1993) had several limitations. One limitation was that the gender differences effect that appeared in the analysis was not taken into consideration by the authors, but they did put this variable as a recommendation for future research. Another limitation was that students majoring in a social science were in an intervention program for helping students with difficulties in statistics.

Several recommendations were suggested in this study that may help the researcher in the current study. One can mention adopting statistical language in other majors, which will make the student more familiar with the language of statistic, which is a procedure called statistics as a second language. Also it is possible to recommend statistical projects in other courses, such as an applied statistics project that students should submit in any course other than statistics courses. Reviewing very basic math skills at the beginning of the course was a recommendation by the authors which contradicted other studies done before that recommended a sequence of math courses as a prerequisite before taking any statistics courses. The current study will test these variables and will recommend whether taking prerequisite courses is helpful or just a simple review of mathematical skills may have a difference on students' performance in statistics courses.

A study done by Vanhoof and Sotos in 2006 used Wise's instrument for measuring attitudes toward statistics and their relationship with short- and long-term statistics exam results. The study was done within five years. The result of this study showed similar results to previous reported literature: high internal consistency for the ATS, but different data was provided. Also the relation to the attitude with the short-term exam revealed similar results to other authors. More specifically, the results on the *Course* subscale indicated that the undergraduate students in Educational Sciences had an attitude toward the particular course in which they were enrolled that was more positive than the attitudes of undergraduate students elsewhere, but comparable to the attitudes of graduate students in other studies. In addition, attitudes toward the course were more highly related to statistics exam results than the attitudes toward the field. The results suggested that students who recognized the importance of statistics for their field of study (in the case of the present study: educational sciences) tended to obtain a better dissertation grade.

Next, the Vanhoof and Sotos (2006) study also investigated the relative predictive value of effective (ATS) and cognitive (exam results) measures in predicting later exam results. This finding is similar to the findings of Roberts and Bilderback (1980), namely that a cognitive measure predicted statistics performance with slightly higher accuracy than the measure of attitudes toward quantitative concepts. These results are an important indicator of the essential role attitudes toward statistics (besides cognitive characteristics) play for the development of statistical competence. The reader may ask after examining this study, if it will be good to follow up the non-successful students, to compare the attitudes and statistics performance of these students with the students who did pass the

exams. The study helped to make a good overview of the relation between attitudes toward statistics with the short-term exam, which may be related to the current study attempt, but results with the long-term exam will not be a case in the present work.

In Economics, the author of an article that investigated the effect of (1) students' responses to a brief questionnaire (containing questions about students' backgrounds in economics, statistics and mathematics); (2) official records; and (3) teachers' own records (concerning performance), used a multiple regression analysis to determine which student characteristics appear to influence the performance measure utilized in this study. The results revealed that a greater background in economics, where undergraduates are concerned, does not appear to be a prerequisite for success in economic statistics. Moreover, some undergraduate students may have a considerable background in economics but may have problems in economic statistics relative to other students.

Concerning graduates students, the effect of a greater economics course background is positive, but quite small. Greater background in mathematics is significantly related to success in the course. Formal or informal mathematics prerequisites might be useful. Such prerequisites appear to be of more importance for undergraduates than for graduates. Moreover, mathematics prerequisites appear to be useful mainly when a limited background in mathematics is required or suggested. Considering the limitations in the study, there may be variables having an effect on students' performance other than those tested, but the author ignores them. He also ignores external or internal influences. In addition, the model could be improved even where the nonlinearity was considered.

 In consequence, further investigation of performance in statistics courses, utilizing various measures of performance, sets of explanatory variables, and functional forms of model would contribute to our understanding of the factors which affect performance of students. Armed with information of this sort, department heads, curriculum officers, teachers and students could all benefit provided that such information is utilized by all concerned in planning for a more effective and rewarding curriculum. (Cohen, 1972, 106)

As was stated in the introduction of this section, the easiest way to look at student outcomes was to consider the grades given at the end of the term or semester. These grades formed the hard data collected to analyze student outcomes. Final grades are a widely and commonly used measure of student achievement. In many studies 'final grades' were used as a dependent variable (Breslow, 2005; Dillon and Kokkelenberg, 2002; Hall, 2008; Martins & Walker, 2006; Shachar & Neumann, 2003). *Final grades* are considered to be an objective measurement of academic performance, compared to more *subjective* measures such as attitudes, expectations, satisfaction and evaluation factors (Shachar & Neumann, 2003). According to Shachar and Neumann (2003), although final grades are prone to assessor subjectivity, they are still a more objective measure than other factors.

Another reason for using final grades is accessibility of this information. Furthermore, comparability across institutions is an important reason for using final grades. The grading was done similarly across institutions, despite the use of so many different teaching and assessment methods. In the end, the final grade (4-point, 10-point and 20-point) was the weighted average of partial grades throughout the semester. All

grading systems were transformed to a 10-point system. In general, two systems of grading were used:

1.   Numerical grading system, going from 1 to 100. Usually 60 out of 100 meant that the student had passed the course.

2.   Letter grading system, going from F (fail) to A (excellent). This system has been adopted from the Anglo-Saxon system by some universities in Lebanon. Usually a D+ still means a provisional pass.

In what way does the final grade reflect the expectations the student had at the start of the course? And, during the semester, did this expectation change? In order to answer this question, expected grades should be measured as a more subjective element of academic performance (Shachar & Neumann, 2003) and compared to final grades. For what purpose? With this study the researcher wanted to establish to what extent the student had realistic expectations of his own performance. Should the course become difficult at the end, expectations were assumed to go down. If the student was self-confident, their expected grade was assumed to be higher compared to students with low self-confidence. If expectations played a role in predicting student achievement, as in course outcome, it was assumed that expectations mediate the effect of individual factors and attitudes on grades.

CHAPTER III

METHODOLOGY

In this study, the researcher studied the relationship between several factors and student's performance in the business statistics courses. Specifically, a regression model was used to examine the relationship between factors which may have a relationship with the grades earned by students when they complete the business statistics course. The researcher included a range of measures of mathematics skills, including the math courses students have taken and student scores on the mathematics portions of the Lebanon admission exam. In addition, math skills were measured by student scores on a test of very basic mathematical skills, such as the ability to calculate the value under the square root and the slope of a line or the area of a triangle, or to divide by a fraction.

Attitude toward statistics have been also investigated in this study to check their relationship with student's performance on introductory and advanced statistics courses. The Survey of Attitudes toward Statistics (SATS) with its six subscales was the tool used to study this relationship. The purpose of the study was to answer the following questions: Are students' math scores on the Lebanon admission exams, their scores on a test of basic mathematical skills, and their attitude toward statistics, related to their performance in introductory or advanced statistics courses?

The Dependent Variable

The students' scores in the statistics courses was the dependent variable measured; the difference in the subjective nature of assessment was controlled by setting a common final exam, and sending its solution to the teachers with the weight of each question. The two final exams in the introductory and advanced courses were assumed

equivalent. Although instructors may place more or less emphasis on calculating correctly, subjectivity in grading eliminates problems with multiple-choice exams where women have been shown to fare significantly worse than men (Williams, Waldauer, & Duggal, 1992).

Letter grades received in statistics courses have been previously used by other researchers studying statistical assessment (Krieg & Uyar, 2001). However, the final grade in the course, represented in numerical form ranging from 0 to 100, was chosen as the dependent variable in this study. The summary statistics for the dependent variable was reported in tables.

At this university, course grades are given out as A which is equivalent to grades that range from 90 to 100, B is equivalent to grades that range from 80 to 90, C is equivalent to grades that range from 70 to 80, D is equivalent to grades that range from 60 to 70, and F for grades lower than 60. For this study actual numerical grades will be used with zero being the lowest grade and 100 being the highest grade.

<div align="center">The Independent Variables</div>

Math skills

Student's math ability was measured using several variables: fifteen simple multiple choice questions on mathematics quiz, in addition to their math scores on the admission exam in Lebanon, their own rate of their math skills, and the number of math courses taken before this course.

At this university, students are not required to take a remedial math course even with low math scores on the admission exams conducted by the Ministry, which is the only requirement for enrolling as a business majors. The course, managerial math, does

not count toward math courses because it contains economical interpretations with no math except finding regions with straight lines. The number of courses taken before statistics courses had been reported in several studies to be a very important variable affecting the success of students in statistics courses (Tomasetto et al., 2009).

Students are required to pass the admission exam in its four sections; otherwise they will not be able to enroll in universities in Lebanon. Students' scores on the admission exams were studied to investigate any relationship with student's final grade in the introductory or in the advanced statistics courses.

The analysis of the student's rate from one to ten as one represents low mathematical skills and ten represents high mathematical skills was also investigated and was measured. Analysis of this issue is important, because it affects the rate of statistics re-enrollment in business statistics classes and, thus, the number of semesters that it takes students to graduate. If students find it more difficult to enter the business school because their lack of math skills and, perhaps, to graduate in a timely fashion, some will decide to select less restrictive majors (Green et al., 2007)

Thus, the study contained several distinct measures of quantitative ability: (1) student scores on the math section of Lebanon admission exams; (2) students' self-reports of their own mathematical skills; (3) the score on the math quiz administered early in the semester; and (4) whether the student has taken math courses before the statistics course

Attitude Toward Statistics

Because attitudes and expectations can influence performance in a statistics class (Onwuegbuzie, 2003), the attitudes toward statistics with its six components was the second independent variable being measured. Several instruments were reported to

measure the attitude of students as mentioned in an earlier section; in this study the SATS in its latest version with six components (Schau et al., 1995) was used after gaining permission.

In addition to the above independent variable, the study also investigated the relationship of the gender and student's grade point average with final grade scores.

Participants

The data for this study was collected from several sections of business statistics in the fall semester of 2011. There were 567 students were enrolled in the course, taught by ten different professors in seven different campuses across Lebanon, and this could ensure random sampling. Each section had approximately 30 students initially enrolled; the students were Caucasian, with an average age of twenty years old. The sample included a higher number of males than females.

The sample represented a middle socioeconomic level of students across Lebanon; it is a university with seven campuses across Lebanon, and so it could be a good representative of business statistics students in Lebanon. The large sample size ensured a high power for the test used.

Instrumentation: Course Description and Objectives

Business statistics courses are 200 and 300-level university courses in statistical analysis taught by all business and economics departments. Ten different statistics professors participated in this study. The courses are designed primarily for business majors. There are no mathematics prerequisites or a university math placement exam, and class sizes average roughly 30 students.

The course covers descriptive methods, probability and inference, regression and correlation (Lebanese International University, 2010). In the university where the study was conducted, a coordinator of statistics is responsible for designing the course content, writing the syllabus, choosing the assignments from text book and developing a common final exam with the same grading system. Since the instructors use common course syllabi, all professors covered the same topics, and had course objectives that include the ability to apply appropriate statistical techniques to analyze data and the ability to interpret the results of statistical calculations.

Instructors teaching this course graded material included bi-weekly homework assignments involving pure technical computations, analysis and explanation, two subjective tests, and two lab sessions for statistical software (SPSS).

Instructors used high complexity of mathematics in lectures (e.g., Instructors often use calculus in lectures) and a high degree of complexity of numerical calculation on exams and homework. By setting a common final exam, with a common solution and weights on questions, the researcher controlled the diversity between instructors.

Questionnaire

The data for the independent variable was collected using a survey consisting of three sections:

Student information

Twelve questions concerning students demographic, motivation, hours spent using the internet and previous math experience was included. In addition to these variables, they were asked about their admission exam math scores; this was being controlled by checking the records of students' admission exam math scores from the

government. Also their GPA in the last semester attended was provided by the university;

permission to check those records was signed and approved by the people responsible

and listed in the appendices. The distributions of all the explanatory variables collected in

this study were reported in tables. The background information gathered on students in

this study may be similar to other studies in statistics, identifying GPA and gender as

important confounding variables (Utts, Sommer, Acredolo, Maher, & Matthews, 2003).

Survey of Attitude Toward Statistics (SATS)

The second part of the survey consisted of the Survey of the Attitude Toward

Statistics (SATS) post version which consists of 36 questions to measure students'

attitudes toward statistics designed by Shau (2004) and was used after her permission.

The first version of the instrument was first done by Shau in1995 and contained 28

items; it was later updated by her to attain 36 items. At first, the SATS was made up of

four subscales: Affect (six items): Students' positive and negative feelings about

statistics, Cognitive Competence (six items): Attitudes about the students' intellectual

knowledge and skills when applied to statistics, Value (nine items): Attitudes about the

usefulness, relevance, and worth of statistics in personal and professional life, and

Difficulty (seven items): Attitudes about the difficulty of statistics as a domain.

The items in each subscale with the reliability scale Cronbach alpha is given

below as reported by the literature. An addition of six items is used (Shau, 2004),

measuring students' expectations toward statistics and divided into two subscales;

Interest (4 items) and Effort (4 items). The six subscales in the survey:

Affect – students' feelings concerning statistics (6 items; .80 to .89):

    3.   I like statistics.

4.*   I feel insecure when I have to do statistics problems.

15.*   I get frustrated going over statistics tests in class.

18.*   I am under stress during statistics class.

19.   I enjoy taking statistics courses.

28.*   I am scared by statistics.

Cognitive Competence-students' attitude about their intellectual knowledge and skills when applied to statistics (6 items; .77 to .88)

5.*   I have trouble understanding statistics because of how I think.

11.*   I have no idea of what's going on in this statistics course.

26.*   I make a lot of math errors in statistics.

31.   I can learn statistics.

32.   I understand statistics equations.

35.*   I find it difficult to understand statistical concepts.

Value – students' attitudes about the usefulness, relevance, and worth of statistics in personal and professional life (9 items; .74 to .90)):

7.*   Statistics is worthless.

9.   Statistics should be a required part of my professional training.

10.   Statistical skills make me more employable.

13.*   Statistics is not useful to the typical professional.

16.*   Statistical thinking is not applicable in my life outside my job.

17.   I use statistics in my everyday life.

21.*   Statistics conclusions are rarely presented in everyday life.

25.*   I will have no application for statistics in my profession.

33.*   Statistics is irrelevant in my life.

Difficulty – students' attitudes about the difficulty of statistics as a subject (7 items; .64 to .81):

6.   Statistics formulas are easy to understand.

8.*   Statistics is a complicated subject.

22.   Statistics is a subject quickly learned by most people.

24.*   Learning statistics requires a great deal of discipline.

Interest – students' level of individual interest in statistics (4 items, new component):

12.   I am interested in being able to communicate statistical information to others.

20.   I am interested in using statistics.

23.   I am interested in understanding statistical information.

29.   I am interested in learning statistics.

Effort - amount of work the student expends to learn statistics (4 items, new component):

1.   I tried to complete all of my statistics assignments.

2.   I worked hard in my statistics course.

14.   I tried to study hard for every statistics test.

27.   I tried to attend every statistics class session.

Additional items:

Item numbers are the same in pretest and posttest versions, with the noted exception:

Single global attitude items (3 pre, 4 post)-

Math Cognitive Competence:

37. How good at mathematics are you?

Career Value:

38. In the field in which you hope to be employed when you finish school, how much will you use statistics?

Statistics Cognitive Competence:

39. How confident are you that you can master introductory statistics material?

Effort (post only):

45. In a usual week, how many hours did you spend outside of class studying statistics?

Academic background items -

Prior Math Achievement**:**

8. (First part of Questionnaire): On a scale of 1-10 how would you rate your Math skills? With 1 as low and 10 as perfect:

Global Post-Secondary Achievement:

7. (First part of questionnaire) what is your cumulative GPA in the last semester?

Prior Math Course Experience:

11. (First part of questionnaire) since graduating from high school, how many Math courses did you completed?

1. Reversing the responses to the negatively worded items indicated with an asterisk* (1 becomes 7, 2 becomes 6, etc.),

2. Summing the item responses within each component, and

3. Dividing by the number of items within each component.

The possible range of scores for each component was between 1 and 7. Using this 7-point Likert scale, higher scores corresponded to more positive attitudes.

The psychometric properties of the SATS were investigated by Luh, Takahashi and Wisenbaker (2004). In the present study, the Cronbach alpha was used to test the reliability of the items, and to investigate whether any subscale should be excluded, which can be seen in the results section.

Several attitude assessment instruments exist and are used in research, such as the Statistics Attitude Survey (SAS), which was developed by Roberts and Bilderback (1980), and the Attitudes toward Statistics (ATS), which was developed by Wise (1985) in an attempt to improve the perceived limitations of the SAS. Another instrument, the Coping Strategies Inventory for Statistics (CSIS), was designed by Jarrell and Burry (1989).

SATS has been widely tested and its reliability was highly reported in the literature. The diversity of scales on the SATS gives this instrument validity to measure students' attitudes toward statistics.

Math quiz

The third section of the survey consisted of a quiz adapted from a study done by Ballard and Johnson (2004) and was adjusted in this study to the level of math given in Lebanon by changing and adding five questions. The researcher obtained the permission of Ballard and Johnson (Appendix D). The math quiz provided information about the students' mathematical knowledge on basic material without being prepared. The quiz was designed to provide information on Lebanese students' mathematical knowledge without preparation and their knowledge of basic material. The math quiz was originally developed for introductory economics, based on years of teaching as mentioned by the authors of the quiz (Ballard & Johnson, 2004). The particular math concepts covered by

the quiz are similar to those reviewed in introductory statistics textbooks. The researcher also performed subjective cleaning of the data, removing the students for whom there was reason to believe that their math quiz score may have been unreliable.

One can argue that this quiz is important in testing students' math ability to perform statistics calculations and interpretations. For example, a student who cannot compute areas will likely have difficulties in manipulating standard normal probabilities; a student who struggles in calculating square roots may have difficulties in calculating variance and standard deviations. Also, a student who does not understand fractions or division may have difficulty in understanding standardized scores and standard errors, and a student who cannot find the slope of a line will likely be unable to correctly interpret the slope in a linear regression.

Final exam

The instrument that was used in this study to measure the dependent variable was students' final exam scores divided in two scores, one for the students in the introductory course and the other for the students in the advanced course. The study goal was to investigate the effect of the instruments mentioned above on the achievements of the student in the statistics courses. Final grades in the statistics courses were reported by the teachers after grading a common final exam. This final exam was assumed equivalent in both courses. These grades were added to the overall grades of the students during the course and reported as the ratio variable under investigation. Additional investigation was done to test if there was a difference in the relationship between the independent variables mentioned above and the reported dependent variables in both courses separately.

Pilot Study

A pilot study was developed and administered in spring 2010 so that any additional needed investigation could be identified. It involved preliminary data collection, using the planned methods, and 140 randomly selected students. The aim was to test out the researcher's approach and identify any details that needed to be addressed before the main data collection.

The authors of the math quiz claimed that this quiz was developed on the basis of years of teaching and that several trial runs were performed in previous semesters, resulting in the final quiz reported (Ballard & Johnson, 2004). The pilot study was conducted with a change of five questions after the permission of the authors of the quiz. Students did not report any problem with the entire quiz including the new questions.

The results of the pilot study suggested an increase in the time given to fill the questionnaire, and the investigator decided that it should be completed in thirty minutes instead of twenty. The psychometric properties of the SATS were investigated by Luh et al. (2004). In this pilot study, the Cronbach alpha was 0.776 and increased to 0.814 when the subscale Difficulty was excluded.

Procedures

To relate the independent variables and the attitude scores to students' achievement in statistics courses, several steps were followed in collecting data and analyzing the results.

1. The study was conducted in the last week of the fall semester of 2011, after the drop period of the courses ended. Therefore, students who completed the survey were the students who completed the course, which reduced the bias in the data.

2. A meeting was conducted between the researcher and the instructors who were going to teach this course in the fall across the campuses of the university; the researcher explained the steps that should be followed in collecting and reporting the data.

3. Instructors who taught the course were responsible for administrating the questionnaire in the class during one session of the course. This session was during the last week of the semester. After collecting the questionnaire, the instructors entered the data on Excel sheets; the latter was provided during the meeting. Students had the right not to participate in the survey, and if they chose not to, they were asked to stay quiet until other students finished completing the survey.

4. The questionnaire began with assuring confidentiality of the students' information, which would be anonymous to the researcher. Students' willingness to complete the survey was their consent to participate in the study. The ID number of the students was used by the teachers collecting the questionnaires to refer to their final grades in the statistics course at the end of the semester. These grades were included in the provided Excel sheet, and students' ID numbers were replaced by random numbers and sent to the investigator.

5. The survey is divided into three parts; the students were urged to do each part individually. The first part contained 11 questions that required five minutes to complete, followed by the SATS post-test that required 10 minutes, and finally the math quiz that included 15 simple, multiple-choice math questions that

6.   The students completed the survey during thirty minutes, and returned it to the teacher in order to be entered onto the Excel sheet. A copy of the questionnaire was provided in the appendixes (Appendix A).

7.   Each student's final score in the course, his/her demographic data, the number of corrected answers on the math quiz, and the scores on the SATS were entered by the instructors of the course on the Excel sheet. The ID number of the student was replaced by random numbers to assure anonymity. This Excel sheet was emailed to the researcher, who analyzed the data and reported the results.

8.   In this country, students need to pass one of four admissions exams designed by the government in order to be admitted to universities. All the versions of the exam are subjective. All students enrolled in this study passed the same section of the exam, the sociology and economic section. The mathematics portion of the exam contains problems on analysis, algebra, and simple descriptive statistics with scatter plots and economical function; the scores range from zero to one hundred. The researcher checked students' admissions scores in the ministry of education after gaining its permission. Students' final scores in the course and their GPA were provided by the university upon request of the researcher.

9.   Consent form and IRB approval were provided by the researcher in the appendixes and the study was conducted after this approval (Appendix E).

Data Analysis

The study used four separated multiple regression models; the independent variables were analyzed with the final average of the students in the introductory course then with students' final exam scores in the same course level as the dependent variables. The same independent variables were also analyzed with the final average of the students in the advanced course then with their final exam scores in the same course as the dependent variable. The data was separated into two sections; one for the introductory course and the other for the advanced course. In the advanced course as well as in the introductory course, multiple regressions were techniques for ratio dependent variables, such as the final average score and the final exam score in the course variable, which reported probabilities as estimated coefficients. The researcher assumed that the dependent variable, which represented student performance in the statistics course regardless of the level of the course, is determined by

$$Y' = \sum_{i==1}^{n} a_i \cdot x_i + \varepsilon$$

Where the vector x contains i explanatory variables, a_i is a defined as a k x 1 constant, and the error, ε follows a standard normal distribution. Let $\alpha_1 < \alpha_2 < \cdots < \alpha_7$ be a set of undetermined threshold parameters. he parameters of this model can be estimated using a maximum likelihood function. The procedure was simple using statistical packages such as SPSS with a 95% level of significance. The statistics summary of each model was reported to indicate the good fit of the model and its accuracy; moreover, scatter plots were used to investigate the strength or weakness correlation of the dependent variables, final average score and final exam score, with all the independent

variables.

Analysis of students' information

Student performance may be related to characteristics such as intelligence, motivation, maturity and background. As a proxy for intelligence, the students' cumulative GPA was collected. Motivation may be affected by gender; hence information on these variables was collected. Background, as far as statistics is concerned, is typically conceived in terms of the students' exposure to mathematics and statistics courses. One method to represent such background was to consider the number of semester hours earned in each of these fields. Data on these variables were given in descriptive statistics tables.

Analysis of the math quiz scores

To analyze the basic mathematics skills further, in addition to the total math-quiz score, each math question individually was analyzed, and percentages of correct answers were presented in descriptive tables. Questions 1, 2, 5, 9, 13 and 14 deal with very basic concepts in arithmetic, algebra, and geometry including manipulating simple systems of equations, manipulating ratios, dividing fractions, a two-step word problem to find the average and estimating square roots, while the other questions deal with word problems and math formulas needed to be successful in statistics courses.

Analysis of the SATS scores

The subscales were Affect –positive and negative feelings concerning statistics, Cognitive Competence–attitudes about intellectual knowledge and skills when applied to statistics, Value–attitudes about the usefulness, relevance and worth of statistics, and Difficulty–attitudes about the difficulty of statistics as a subject. The subscales are

formed by 6, 6, 9 and 7 items, respectively. The Survey of Attitudes toward Statistics (SATS) (Schau, Stevens, Dauphinee, & Del Vecchio, 1995) has 36 items, with a 7-point likert scale, with the addition of six items measuring the expectation of the student toward statistics. There are four subscales in the survey: Affect, Cognitive Competence, Value and Difficulty, with an extra two subscales Interest and Effort. The higher the score is the more positive the attitude toward statistics is.

The scores of the SATS-Subscales were included and analyzed separately in the model to test which subscale had a significant relationship with the dependent variable under investigation. SATS survey was designed to be administered to students twice, at the beginning of a course and at the end. In this study, the researcher used only the Post-Test since the questionnaire was administrated in the last week of the semester and the attitude toward statistics was not the only factor to be studied. Moreover, the two additional subscales added by Shau in 2004 were of great interest to the researcher and those subscales are presented only in the Post-Test version of the SATS.

Analysis of the dependent variable

The hypotheses discussed earlier in the study were tested in two levels of statistics courses: introductory and advanced. Two dependent variables were used: students' final exam score and the students' final averages in the course. The final exam in both courses was assumed equivalent and was set by the researcher and corrected by the instructor of the course. A comparison of the results in each course is presented in Chapter IV and a discussion of the results is reported in Chapter V.

CHAPTER IV

RESULTS

The primary focus of this study was to determine if specific factors have a

relationship with the outcomes of introductory courses in statistics at Lebanese

Universities. The following central question was formulated:

Are math scores on Lebanese admissions exams (official exams), students' scores

on a quiz of basic mathematical skills and students' attitudes toward statistics related to

students' final grades in business statistics courses?

The study involved three independent variables: Math scores in the admissions

exams, scores on the survey of attitude toward statistics (SATS), and scores on a math

test of simple mathematical skills. The study involved two dependent variables: student

achievement in the statistics course, which was measured by their comprehensive exam

scores and their final grades.

Therefore the goal of this research was to determine whether or not a relationship

exists between student achievement in statistics and several factors including attitudes

toward statistics, mathematical background and admissions exams scores. This chapter

discusses the results of the quantitative data analysis. Descriptive and inferential statistics

are reported, and decisions on the research hypotheses are presented.

Descriptive Statistics

Sample

The sample for this research consisted of 567 students enrolled in multiple

sections of two courses: introductory statistics and advanced statistics. Five different

instructors taught 10 sections of introductory statistics with a total of 307 students. Three

different instructors taught five sections of advanced statistics with a total of 260

students.

Descriptive Analysis of Data

All data were collected using a survey across the seven campuses of the Lebanese International University in Lebanon administered during the last week of the fall semester of 2011.The survey was divided into three sections: demographic information, a 48-item survey of attitude toward statistics (based on a 7-point Likert scale), and a 15-item mathematics quiz. Achievement data included students' comprehensive final exam scores (based on a 100-point scale) and their final course averages (based on a midterm exam, assignments and the final exam). The data were analyzed using the statistical software SPSS.

A detailed analysis of descriptive statistics was conducted on both samples. The minimum, maximum, mean and standard deviation were calculated for the introductory statistics course sample and can be found in Tables 1 and 2. In the introductory course, 47% of the students claimed to have spent more than nine hours per week on the Internet. Similarly, 48% of the students in the advanced course claimed the same. The average age of all students was 21 and only 8% were 25 or older. In the introductory statistics course, 54.1% of the students were males, 73.6% were sophomores, and 44.29% of them had graduated from high school the previous year. In the advanced course, 50.4% were males, 88.46% were seniors and 84.61% had graduated from high school more than two years prior to taking this course.

The average grade point average (GPA) of students in the introductory course was 2.07 and only 11.72% had a GPA higher than 3.0. The average GPA of students in the advanced course was 2.38 and only 11.5% of them had a GPA higher than 3.0. Forty-four

percent of students in the introductory course and 41% in the advanced course reported

having never sought help from their statistics instructors.

Table 1

Descriptive Statistics Introductory Level

	N	Minimum	Maximum	Mean	SD
Internet Hours	304	0	168	19.43	23.02
Age	307	18	31	19.88	2.20
GPA	276	1.8	5	2.07	.83
Final Exam	307	0	96	52.68	20.52
Final Average	307	14	93	65.87	12.60
Valid N	264				

Table 2

Descriptive Statistics Advanced Level

	N	Minimum	Maximum	Mean	SD
Internet Hours	258	0	100	18.49	17.95
Age	260	18	33	21.32	1.86
GPA	253	1	4	2.39	.52
Final Exam	260	0	100	64.59	20.84
Final Average	260	36	95	70.46	11.49
Valid N	243				

Descriptive Statistics

Achievement

Student achievement was determined using two common final exam scores and the overall final course averages. As shown in Table 1, the final exam scores for the students in the introductory course ranged from a minimum of zero for failing the exam to a maximum of 96 out of 100. The final average for the students in the introductory course ranged from a minimum of 14 to a maximum of 93 out of 100 (Mean=65.87, SD=12.6). As shown in Table 2, the final exam score of the students in the advanced course ranged from a minimum of zero for failing the exam, to a maximum of 100 out of 100 (Mean=64.59, SD=20.84). The final average for students in the advanced course ranged from a minimum of 36 to a maximum of 95 out of 100 (Mean 70.46, SD=11.48).

Math skills

Math skills were measured by four different variables for the students enrolled in the introductory course and are reported in Table 3. Students' rated their own math skills an average of 9.24 out of 10. However, their average score on the official math exam was 64.97 out of 100. They took an average of less than two math courses before this statistics course (including college algebra and math for business). Their average on the 15-items of the math quiz used in this study was 9.56 out of 15.

Table 3

Descriptive Statistics Introductory Level Mathematical Skills

	N	Minimum	Maximum	Mean	SD
Rate of Math Skills	303	0	705	9.24	40.14

Table 3 (continued).

	N	Minimum	Maximum	Mean	SD
No of Math Courses Taken	297	0	12	1.43	1.20
Math Quiz	307	1	15	9.56	3.22
Valid N (listwise)	264				

Math skills for students enrolled in the advanced course are reported in Table 4.

Students rated their own math skills an average of 7.29 out of 10. Their average score for

the official math exam or the admission math test was 65.79 out of 100. They had taken,

on average, less than two math courses before this statistics course (including introduction

to statistics and math for business). Their average on the 15-item math quiz used in this

study was 9.15 out of 15.

Table 4

Descriptive Statistics Advanced Level Mathematical Skills

	N	Minimum	Maximum	Mean	SD
Rate of Math Skills	256	1	11	7.29	1.35
Official Exam Math Scores	260	2	100	65.79	17.63
No of Math Courses Taken	255	0	20	1.89	2.07
Math Quiz	260	.00	15	9.15	3.72
Valid N	243				

In addition to student scores on the mathematics official exams in Lebanon, several other measures of students' math ability, including the ability of students to answer 15 basic multiple-choice mathematics questions were examined. This portion of the survey was designed to supplement traditional sources of information regarding Lebanese students' math skills. The math quiz provided additional information, including: (1) student mathematical knowledge on a given day, without preparation or studying; and (2) student knowledge of extremely basic material, not extensively covered by collegiate entrance exams. The reliability of the quiz was 0.791. The math quiz, as well as the percentage of the survey respondents who answered each question incorrectly, are presented in Appendix B.

As indicated in Appendix B and Table 5, between 26.8% and 27% of the students in the introductory course and between 20.6% and 31.3% of the students in the advanced course could not simplify radicals. Further, 33% of the students in the introductory course and 33.5% in the advanced course could not find the area of the triangle; and 24.4% of the students in the introductory course and 19.1% of the advanced course could not calculate percentages.

Table 5

Percentages of Incorrect Answers in Both Levels

Question	Introduction	Advanced
Q1	13.3%	12.6%
Q2	12.4%	12.9%
Q3	14.8%	10.2%
Q4	18.1%	11.7%

Table 5 (continued).

Question	Introduction	Advanced
Q5	26.8%	20.6%
Q6	19.8%	14.7%
Q7	33%	33.5%
Q8	21.8%	19.1%
Q9	16.7%	19.6%
Q10	13%	13.5%
Q11	15.7%	13.8%
Q12	27%	31.3%
Q13	16.7%	14.4%
Q14	24.4%	19.1%
Q15	11.6%	17%

While these exact mathematical skills may not be used directly in statistical calculations, these results suggest that a significant number of students would likely have difficulty in not only performing statistical calculations, but also understanding or interpreting statistical calculations. For example, a student who cannot compute areas will likely struggle with manipulating standard normal probabilities, a student who does not understand percentages or division may have difficulty in understanding means or standard deviations, and cannot interpret descriptive statistics. Also, a student who cannot find the slope of a line will likely be unable to correctly interpret the slope in a linear regression.

The percentage of incorrect answers was higher for the introductory course students compared to the students in the advanced course except for the questions regarding finding the slopes and simplifying radicals; students in the advanced course had a higher percentage of mistakes compared to the students in the introductory course. Otherwise, the percentages of incorrect questions were very close and approximately the same between the two groups.

The researcher also included measures of the mathematics courses students have taken. At Lebanese universities, students majoring in business are required to take only one math course: math for business. This course covers very basic math such as finding slopes, derivatives and integration. Some students choose to register for college algebra in their first semester as an elective course. (In this sample, 95% of the students reported taking fewer than two courses prior to their statistics course). The researcher asked whether students took a calculus or business calculus course, but none did. The variables are summarized in Table 3 and Table 4.

Thus, the study included several distinct measures of math ability: (1) students' scores on the math section of the official exam; (2) students' rating of their own mathematical skills; (3) students' scores on the math quiz administered in the survey at the end of the semester; and (4) whether the students had taken math courses prior to taking statistics.

Survey of Attitudes toward Statistics (SATS)

The minimum, maximum, mean and standard deviation were calculated for SATS. The responses were on a 7-point Likert scale (1=*Strongly Disagree* to 7=*Strongly*

Agree) for the two groups using each of the 6 subscales: Cognitive, Value, Difficulty, Interest, Effort, and Affect.

Table 6 provides these statistics for the introductory level.

Table 6

Descriptive Statistics of SATS Subscales Introductory Level

	Minimum	Maximum	Mean	SD
Cognitive	2.50	7.00	5.55	1.04
Value	2.44	7.00	4.23	.75
Difficulty	2.25	6.25	4.72	.82
Interest	1.25	7.00	5.25	1.19
Effort	2.50	7.00	5.46	1.15
Affect	2.25	7.00	5.13	1.03
Valid N	307			

Table 7 provides these statistics for the advanced level.

Table 7

Descriptive Statistics of SATS Subscales Advanced Level

	Minimum	Maximum	Mean	SD
Cognitive	2.83	7.00	5.64	.90
Value	1.33	6.33	4.20	.80
Difficulty	2.00	7.00	4.25	.85
Interest	1.00	7.00	5.14	1.21
Effort	2.00	7.00	5.67	1.06
Affect	2.17	7.00	5.11	1.01
Valid N	260			

As shown in Table 6 and Table 7, survey responses under the Cognitive subscale for the group of students in the introductory course (Mean=5.55, SD=1.04) range from a minimum of 2.5 to a maximum of 7.00, while responses of the group of students in the advanced course (Mean= 5.63, SD=0.90) range from a minimum of 2.83 to a maximum of 7.00.

Value was the second subscale from the SATS survey. Value responses from the students in the introductory course (Mean= 4.23, SD=.74) range from a minimum of 2.44 to a maximum of 7.00, while the responses of students in the advanced level (Mean= 4.2, SD=.79) range from a minimum of 1.33 to a maximum of 6.33.

The third subscale analyzed from the SATS survey was Difficulty. The subscale responses from the students in the introductory course (Mean= 4.7, SD=.82) range from a minimum of 2.25 to a maximum of 6.25, while the responses of students in the advanced level (Mean= 4.25, SD=.84) range from a minimum of 2.00 to a maximum of 7.00.

Interest was the fourth subscale, and students' responses in the introductory course (Mean= 5.25, SD=1.18) range from a minimum of 1.25 to a maximum of 7.00, while the responses of students in the advanced level (Mean= 5.14, SD=1.21) range from a minimum of 1.00 to a maximum of 7.00.

The Effort subscale responses from the students in the introductory course (Mean= 5.45, SD=1.14) range from a minimum of 2.5 to a maximum of 7.00, while the responses of students in the advanced level (Mean= 5.67, SD=1.06) range from a minimum of 2.00 to a maximum of 7.00.

For the last subscale, Affect, responses from the students in the introductory course (Mean= 5.12, SD=1.03) range from a minimum of 2.25 to a maximum of 7.00,

while responses from students in the advanced level (Mean= 5.11, SD=1) range from a minimum of 2.17 to a maximum of 7.00.

In four of the subscales, except for the subscales Effort and Cognitive, the attitudes of the students in the advanced course were slightly lower than the attitude of the students in the introductory course.

The means of four of the SATS subscales were high (more than 5.00) which reflects a high positive attitude toward statistics. Although the two subscales Difficulty and Value had lower means than the other subscales (range between 4.2 and 4.5), they still reflect a high positive attitude for students in both levels.

Analyzing each subscale separately, the results are shown in Tables 8, 9, 10, 11, and 12 below.

Table 8

Descriptive Statistics of SATS Cognitive-Subscale Introductory Level vs. Advanced Level

	Mean I	SD I	Mean A	SDA
Q5. I have trouble understanding statistics because of how I think*	5.57	1.67	5.4	1.65
Q11. I have no idea of what's going on in statistics*	5.78	1.75	6.21	1.31
Q26. I make a lot of math errors in statistics*	4.78	1.71	4.86	1.8
Q31. I can learn statistics.	6.01	1.52	6.15	1.19
Q32. I understand statistics equations.	5.95	1.32	5.9	1.25
Q35. I find it difficult to understand statistics concepts*	5.23	1.68	5.31	1.5
Valid N	307		260	

*items are reversed, I: Introductory level A: advanced Level

The results of the cognitive competence subscale measuring attitudes about intellectual knowledge and skills when applied to statistics revealed higher means in the

advanced course than in the introductory course. Moreover, the highest mean went to the

question in which the students revealed that they can learn statistics (Mean= 6.01 in the

introductory course and Mean= 6.15 in the advanced course.) This may be due to the fact

that students in the advanced course are more confident in learning statistics because it is

their second course.

Table 9

Descriptive Statistics of SATS Value-Subscale Introductory Level vs. Advanced Level

	Mean I	SD I	Mean A	SDA
Q7. Statistics is worthless.*	5.34	1.74	5.38	1.72
Q9. Statistics should be a required part of my professional training.	4.48	1.657	4.36	1.61
Q10. Statistical skills will make me more employable.	5.03	1.59	4.78	1.67
Q13. Statistics is not useful to the typical professional*	4.97	1.62	5.1	1.57
Q16. Statistical thinking is not applicable in my life outside my job*	4.43	1.81	4.38	1.84
Q17. I use statistics in my everyday life.	3.65	1.84	3.71	1.78
Q 21. Statistics conclusions are rarely presented in everyday life*	3.97	1.63	4.04	1.64
Q25. I will have no application for statistics in my profession*	4.5	1.57	4.52	1.63
Q33. Statistics is irrelevant in my life.*	4.37	1.62	4.28	1.65
Valid N	307		260	

*items are reversed
I: Introductory level A: advanced Level

There were no difference between the means in the introductory course and the

means in the advanced course. The means on the Value subscale were lower than other

subscale which means that students in both levels had negative attitudes toward the value

and the usefulness of statistics in personal and professional life. This result may explain the low achievement of the students in their final average in the course.

Table 10

Descriptive Statistics of SATS Difficulty-Subscale Introductory Level vs. Advanced Level

	Mean I	SD I	Mean A	SDA
Q6. Statistics formulas are easy to understand	5.62	1.54	5.1	1.6
Q8. Statistics is a complicated subject.	5.00	1.86	4.55	1.78
Q22. Statistics is a subject quickly learned by most people	4.84	1.51	4.21	1.5
Q24. Learning statistics requires a great deal of discipline	3.43	1.38	3.13	1.29
Q30. Statistics involves massive computations.	3.69	1.44	3.16	1.39
Q34. Statistics is highly technical.	3.27	1.46	2.94	1.34
Q 36. Most people have to learn a new way of thinking to do statistics.	3.31	1.6	3.29	1.54
Valid N	307			260

*items are reversed
I: Introductory level A: advanced Level

For the Difficulty subscale, the means in both courses were low which reflected the students' negative attitudes toward the difficulty of statistics as subject. However, the highest mean appeared in the introductory course where the students agreed that statistics formulas are easy to understand.

Table 11

Descriptive Statistics of SATS Interest-Subscale Introductory Level vs. Advanced Level

	Mean I	SD I	Mean A	SDA
Q12. I am interested in being able to communicate statistical information to others	5.1	1.64	4.96	1.56
Q20. I am interested in using statistics.	5.17	1.49	5.12	1.52
Q23. I am interested in understanding statistical information	5.44	1.43	5.12	1.55
Q29. I am interested in learning statistics.	5.3	1.58	5.38	1.44
Valid N	307			260

I: Introductory level A: advanced Level

Table 11 revealed a positive attitude toward statistics when the interest in learning

statistics is the aim. The interest in statistics as subject is higher at the introductory level

than the advanced level. Moreover, the highest mean appears at the introductory level

when the students claim that they are interested in understanding statistical information

(Mean= 5.44).

Table 12

Descriptive Statistics of SATS Effort-Subscale Introductory Level vs. Advanced Level

	MeanI	SD I	MeanA	SDA
Q1. I complete all of my statistics assignments.	5.68	1.56	5.7	1.47
Q2.I work hard in my statistics course.	5.33	1.48	5.59	1.23

Q14 .I study hard for every statistics test.	5.35	1.58	5.45	1.67
Q27.I attend every statistics class session	5.48	1.76	5.93	1.53
Valid N	307			260

I: Introductory level A: advanced Level

Table 12 revealed higher means in the advanced course than the introductory course which may be due to the need for more effort at the advanced level. A mean of 5.93 reflects that attending all the classes is important to students in the advanced course.

Table 13

Descriptive Statistics of SATS Affect-Subscale Introductory Level vs. Advanced Level

	MeanI	SDI	MeanA	SDA
Q3. I like statistics	5.59	1.63	5.4	1.56
Q4. I feel insecure when I have to do statistics problems*	4.55	1.81	4.65	1.7
Q15. I get frustrated going over statistics tests in class*	4.58	1.76	4.48	1.67
Q18. I am under stress during statistics class*	5.3	1.84	5.56	1.66
Q19. I enjoy taking statistics courses.	5.25	1.62	5.39	1.69
Q28. I am scared by statistics*	5.5	1.7	5.15	1.67
Valid N	307		260	

 *items are reversed
I: Introductory level A: advanced Level

The six items measured the positive and negative feelings toward statistics. The higher the sum is, the more positive the attitude will be. Table 14 revealed that students in the introductory course had more positive attitudes toward statistics than students in the advanced level. This result indicates that when students are enrolled in the introductory statistics courses, they have more positive attitude toward statistics than students enrolled in advanced statistics courses. Further, the highest mean appeared in question one where

the students expressed their positive feeling toward statistics (Mean=5.59 in the introductory course and Mean=5.4 in the advanced course).

Reliability

The reliability test of the SATS revealed a Cronbach alpha of .86 when including all the items of the SATS subscales. Testing the reliability of each subscale, the researcher obtained a Cronbach's alpha for the Affect subscale–students' feelings concerning statistics (6 items; .64); The Cognitive subscale –students' attitudes about their intellectual knowledge and skills when applied to statistics (6 items; .70); The Value subscale– students' attitudes about the usefulness, relevance, and worth of statistics in personal and professional life (9 items; .65); The Difficulty subscale – students' attitudes about the difficulty of statistics as a subject (7 items; .60); The Interest subscale– students' level of individual interest in statistics (4 items, new component; .78); The Effort subscale - amount of work the student expends to learn statistics (4 items, new component;.69). Except for Difficulty, which revealed a lower Cronbach's alpha, the reliability of the items in each subscale is similar to those reported in the literature.

Regarding the Math quiz, the reliability test revealed a Cronbach alpha of .79 which is higher than the Cronbach alpha reported in the literature.

<center>Inferential Statistics</center>

The purpose of this research was to investigate the relationship between several factors and students' achievement in statistics courses. The independent variables included in this research were the students' mathematical skills, attitudes toward statistics using SATS, and the characteristics of the students such as their gender, GPA, time spent on Internet and whether they seek help from the instructor outside the classroom. The

dependent variable, students' performance, was measured by the final average and the scores on a common final exam of the students in both introductory and advanced statistics courses. This relationship was tested using a multiple regression model to determine which factor improved students' achievement in both introductory and advanced statistics courses.

At first, factors related to the research hypothesis were included in the regression model and separate correlations were analyzed, then the rest of the factors were added to check for additional inference regarding the data. Statistical tests were performed using an alpha of 0.05 to determine significance. Four hypotheses were tested and decisions were made to reject or accept the hypotheses.

Testing of Hypotheses

The hypotheses were divided according to the level of the course and whether the dependent variable measured was the final average or the final exam in the course. Stated as follows:

H_1: There is a significant relationship between students' scores on (1) the math part of the official exam, (2) a simple mathematical skills test, (3)students' attitudes toward statistics, and (4) student's *final average* in *introductory* business statistics courses. The regression model for this hypothesis was

Final average in the introductory level $= \alpha_1 \times$ *student score on the math official exam* $+$ $\alpha_2 \times$ *student score on the math quiz* $+ \alpha_3 \times$ *affect* $+ \alpha_4 \times$ *Cognitive* $+ \alpha_5 \times$ *Effort* $+$ $\alpha_6 \times$ *Value* $+ \alpha_7 \times$ *Interest* $+ \alpha_8 \times$ *Difficult*

Results from the Regression model were $R^2 = .10$, F (8,306) = 4.091, p=0.00012 and indicated that there is a significant relationship between student achievement in the introductory level course and several factors such as students' mathematical skills,

attitudes toward statistics and the math part of the official exam. These significant

variables explained a significant proportion of variance in final average scores at the

introductory level. The research hypothesis H_1 was supported. This suggests that the

above factors contribute to student achievement.

When considering the coefficients analysis, it appears that the math quiz

significantly predicted students' final averages at the introductory level, $\beta = -.12$, t (306) =

-2.17, p=0.03;, in addition to the math quiz, the Cognitive subscale of the attitude toward

statistics significantly predicted students' final averages at the introductory level, $\beta =$

.25,t (306) = 3.19, p=0.002.

Table 14 provides the estimated coefficients and significance for the final average at the

introductory level.

Table 14

Estimated Coefficients and Significance of the Final Average for the Introductory Level

Variables	b	SD error	β	t-statistics	p-value

Table 14 (continued).

Variables	b	SD error	β	t-statistics	p-value
Official Exam Math Score	.03	.03	.08	1.36	.18
Math Quiz	-.48	-.48	-.12	-2.17	.03[*]
Cognitive	3.03	3.03	.25	3.19	.002[*]
Value	.36	.36	.02	.34	.73

Difficulty	.41	.41	.03	.54	.60
Interest	-.43	-.43	-.04	-.54	.59
Effort	.03	.03	.002	.04	.97
Affect	.71	.71	.06	.74	.46

*p<.05

Thus, only simple math skills are needed to achieve in introductory statistics courses in addition to the cognitive competence, which reflects the attitude of the students about intellectual knowledge and skills applied to statistics.

The correlation analysis of each factor with students' final average in the introductory level of the course is presented in Table 15. A significant correlation appears between the final average of students, the math part of the official exam scores and the six subscales of the SATS.

Table15.

Correlations between Final Average in the Introductory Level and the Independent Variables

		Official Exam Math Score	Math Quiz	Cognitive	Value	Difficulty	Interest	Effort	Affect
Pearson Correlation	Final Average	.09**	-.07	.27**	.11**	.14**	.12**	.10**	.22**
Sig.(2-tailed)		.03	.38	.001	.13	.01	.001	.01	.001

**p<.01

In Table 15, the researcher obtained a significant positive correlation between students' final averages and the four components of students' attitudes toward statistics; a stronger correlation exists between the cognitive and the affect competences and the final averages at the introductory level.

H₂: There is a significant relationship between students' scores on (1) the math part of the official exam, (2) a simple mathematical skills test, (3) students' attitudes toward statistics, and (4) students *final exam scores* in *introductory* business statistics courses.

The regression model for this hypothesis was

Final exam in the introductory level $= \alpha_1 \times$ *student score on the math official exam* $+$ $\alpha_2 \times$ *student score on the math quiz* $+ \alpha_3 \times$ *affect* $+ \alpha_4 \times$ *Cognitive* $+ \alpha_5 \times$ *Effort* $+$ $\alpha_6 \times$ *Value* $+ \alpha_7 \times$ *Interest* $+ \alpha_8 \times$ *Difficult*

Results from the Regression model related to the introductory level of the statistics course and final exam scores were $F_{(8,306)} = 3.78$, $p = .001$, $R^2 = .09$ and indicated that a significant relationship existed between student scores on the final exam in the introductory level and students' scores on the math quiz, attitude toward statistics and math part of the official exam.

The research hypothesis H_2 was supported. This suggests that the above factors have a relationship with the students' scores on the final exam.

When considering the coefficient analysis, it appeared that only the Cognitive subscale of the SATS was significant $\beta = .25$, $t_{(306)} = 3.13$, $p < 0.05$. Therefore, Cognitive competence significantly predicted students' scores on the final exam in the introductory statistics course. This result was reflected in the results of the Regression. Therefore,

intellectual knowledge and skills applied to statistics had an effect on the final grades of

students in the introductory statistics courses. The results can be seen in Table 16.

Table 16

Estimated Coefficients and Significance for the Final Exam at the Introductory level

Variables	b	SD error	β	t-statistics	p-value
Official Exam Math Score	.05	.04	.07	1.19	.23
Math Quiz	-.57	.37	-.09	-1.55	.12
Cognitive	4.86	1.56	.25	3.13	.002[*]
Value	1.83	1.73	.07	1.06	.29
Difficulty	1.92	1.52	.08	1.27	.21
Interest	-.36	1.30	-.02	-.28	.78
Effort	-.50	1.19	-.03	-.41	.68
Affect	.003	1.55	.01	.002	.10

**p<.05

The correlation analysis of each factor with students' final exam scores in the

introductory level presents a positive correlation between the students' scores on the final

exam and the six subscales of the SATS except for the subscale Effort which was not

significant. This may be due to the fact that students in this sample had good average

scores before the final exam and therefore they felt no need to make effort to pass the

final exam. Table 17 represents the correlation between the variables.

Table 17

Correlations between Final Exam in the Introductory Level and the Independent Variables

		Official Exam Math Score	Math Quiz	Cognitive	Value	Difficulty	Interest	Effort	Affect
Pearson Correlation	Final Exam	.10	-.03	.27	.14	.17	.12	.07	.20
Sig. (2-tailed)		.05[**]	.30	.001[**]	.001[**]	.002[**]	.02[**]	.11	.001[**]

**p<.01

In addition to the above, a somewhat weak positive correlation exists between the final exam scores and the official exam math scores with a negative coefficient of correlation.

H_3: There is a significant relationship between students' scores on (1) the math part of the official exam, (2) a simple mathematical skills test, (3) students' attitudes toward statistics, and (4) students *final averages* in *advanced* business statistics courses. The regression model for this hypothesis was

Final average in the advanced level $= \alpha_1 \times$ *student score on the math official exam* $+$
$\alpha_2 \times$ *student score on the math quiz* $+ \alpha_3 \times$ *affect* $+ \alpha_4 \times$ *Cognitive* $+ \alpha_5 \times$ *Effort* $+$
$\alpha_6 \times$ *Value* $+ \alpha_7 \times$ *Interest* $+ \alpha_8 \times$ *Difficult*

Results of the Regression model related to the advanced level of the course and the final average scores were F $(8,259) = 6.020$, p$= .01$, $R^2 = .16$ and indicated that there is a statistically significant relationship between students' final averages in the advanced level course and several factors such as students' scores on a test of simple mathematical skills, attitudes toward statistics and the math part of the official exam.

The research hypothesis H_3 was supported. This suggests that the above factors have a relationship with the students' final averages.

When considering the coefficient analysis, it appeared that only the Effort and Affect subscales of the SATS were significant $\beta = .19$, t $(258) = 3.03$, p $=0.003$ for the effort subscale and $\beta= .23$, t $(258) = 2.77$, p$=0.09$ for the Affect subscale. This was reflected in the results of the Regression. Therefore, the amount of work students were willing to make in learning statistics, were related to their results in the advanced level of the course. Moreover, their positive or negative feelings toward statistics had a

relationship with their final average in the advanced level of the course. The results can

be seen in Table 18.

Table 18

Estimated Coefficients and Significance for the Final Average at the Advanced Level

Variables	b	SD error	β	t-statistics	p-value
Official Exam Math Score	.03	.04	.05	.81	.42
Math Quiz	.18	.19	.06	.95	.34
Cognitive	1.42	1.01	.11	1.41	.16
Value	1.60	.93	.11	1.73	.09[**]
Difficulty	.01	.87	.01	.011	.99
Interest	-.72	.70	-.08	-1.03	.31
Effort	2.02	.67	.19	3.03	.003[*]
Affect	2.67	1.55	.23	.002	.006[*]

[*]p<0.05, [**]p<0.01

Furthermore, a somewhat significant effect of the subscale value appeared in the

table above where $β = .11$, t (258) = 1.73, p=0.09. This means that at the advanced level,

students begin to think about the usefulness, relevance and worth of statistics since they

will be graduating soon.

The correlation analysis of each factor with the students' final average in the

advanced level presents a significant correlation between the students' averages and the

six subscales of the SATS only. This result suggests that the final achievement of

students at the advanced level is affected by their attitude toward statistics more than their

ability in solving math; the results are presented in Table 19.

Table 19

Correlations between Final Average in the Advanced Level and the Independent Variables

		Official Exam Math Math Score	Quiz	Cognitive	Value	Difficulty	Interest	Effort	Affect
Pearson Correlation	Final Average	.07	.02	.30	.20	.10	.17	.21	.32
Sig.(2-tailed)		.14	.40	.001**	.001**	.05**	.003**	.001**	.001**

**p<.01

Looking at Table 19, a positive correlation appeared between the Cognitive, Affect, and Value with the students' final averages at the advanced level.

H_4: There is a significant relationship between students' scores on (1) the math part of the official exam, (2) a simple mathematical skills test, (3)students' attitudes toward statistics, and (4) students' *final exam scores* in *advanced* business statistics courses. The regression model is as follows

Final examscores in the advanced level $= \alpha_1 \times$ *student score on the math official exam* $+ \alpha_2 \times$ *student score on the math quiz* $+ \alpha_3 \times$ *affect* $+ \alpha_4 \times$ *Cognitive* $+ \alpha_5 \times$ *Effort* $+ \alpha_6 \times$ *Value* $+ \alpha_7 \times$ *Interest* $+ \alpha_8 \times$ *Difficult*

Results from the Regression related to the advanced level of the course and the final exam scores were F (8,259) = 3.05, p=.003, R^2 = .09, which indicates that there is a statistically significant relationship between student scores on the final exam in the advanced level course and several factors such as students' scores on a test of simple mathematical skills, attitude toward statistics and the math part of the official exam. The research hypothesis H_4 was supported. This suggests that the above factors have a

relationship with the students' scores on the final exam. Table 20 revealed the results of

the coefficients weights obtained.

Table 20

Estimated Coefficients and Significance for the Final Exam at the Advanced Level

Variables	b	SD error	β	t-statistics	p-value
Official Exam					
Math Score	-.01	.07	-.01	-.11	.91
Math Quiz	.85	.36	.15	2.42	.02*
Cognitive	3.74	1.90	.16	1.97	.05*
Value	2.36	1.76	.09	1.34	.18
Difficulty	-.43	1.64	-.02	-.26	.80
Interest	-.87	1.32	-.05	-.66	.51
Effort	2.03	1.26	.10	1.61	.11
Affect	1.67	1.82	.08	.92	.36

*$p < 0.05$

When considering the coefficient analysis, it appears that the Cognitive subscale

of the SATS was significant β= .16, t (258) = 1.97, p=0.05, and students' scores on a

simple math skills test was also significant β= .15, t (258) = 2.42, p=0.02. This result

means that in the advanced level and regarding students' attitudes, only their attitudes

about intellectual knowledge and skills applied to statistics had a relationship with their

scores on the final exam. Their simple math skills were also significant. This was

reflected in the results of the regression. Thus the more the students know in statistics, the

more positive their attitude will be toward statistics and consequently they will do better

in the final exam. Furthermore, the final exam in the advanced course in this university is

more related to math than the introductory one (regression, hypothesis testing of two

samples, etc…). Therefore, the students' simple math ability is related to their exam scores.

In Table 21, the correlation analysis of each factor with the scores of the final exam in the advanced statistics course presents a significant correlation between the students' scores on the final exam and the six subscales of the SATS except for the subscale Difficulty, as well as a significant correlation between the final exam scores and the math quiz.

Table 21

Correlations between the Final Exam in the Advanced Level and the Independent Variables

		Official Exam Math Score	Math Quiz	Cognitive	Value	Difficulty	Interest	Effort	Affect
Pearson Correlation	Final average	.18	.03	.13	.22	.14	.04	.09	.13
Sig.(2-tailed)		.002**	.34	.02**	.001**	.01**	.29	.07	.02**

**p<.01

The results above suggested that the final exam in the advanced level is related to the students' ability to solve a simple math test. Their attitude toward statistics is related to their scores in the final exam except for their perception of Difficulty in statistics which appeared to not be related to their achievement in the final exam.

Summary

The four hypotheses stated above were supported and the null hypotheses were rejected. The results of the regression analysis showed that whether students' final averages or students' final exam scores were the dependent variables, a statistically significant relationship existed between students' achievement in statistics courses in both levels with several variables. Moreover, a test of simple math, the official exam math scores and students' attitudes toward statistics, are related to the students' achievements in statistics courses in Lebanon. A comparison of the relationship between the independent variables and the dependent variables at both levels is revealed in Table 22.

Table 22

Comparison of the Regression

| | Dependent Variable=Final average | | | | Dependent Variable=Final Exam | | | |
| | Introductory Level | | Advanced Level | | Introductory Level | | Advanced Level | |
Variable	Coefficient	p	Coefficient	p	Coefficient	p	Coefficient	p
Official Exam Math Score	.03	.18	.03	.42	.05	.23	-.01	.91
Math Quiz	-.48	.03**	.18	.34	-.57	.12	.85	.02*
Cognitive	3.03	.02**	1.42	.16	4.86	.002***	3.74	.05*
Value	.36	.73	1.60	.09**	1.83	.29	2.36	.18
Difficulty	.41	.60	.01	.99	1.92	.21	-.43	.80
Interest	-.43	.59	-.72	.31	-.36	.78	-.87	.51

Effort	.03	.97	2.02	.003*	-.49	.68	2.03	.11
Affect	.71	.46	2.67	.006*	.003	.10	1.67	.36
Constant	46.22	.001	2.18	.001	15.93	.001	12.56	.01
R^2	.10		.16		.09		.09	

**p < .01

Table 22 represents the results of the four regression models and their analysis including all the independent variables, within the two levels and using the two dependent variables separately. The highest R^2 was for the advanced level in the final average (R^2=.16). The Cognitive subscale of the SATS was significant at the introductory level in both final exam and final average. The Affect and Effort were significant only at the advanced level in the final average scores; Difficulty, Interest and Value subscales were not significant at both level either using the final exam or the final average as the dependent variable. Moreover, scores on the test of simple Math were significant at the introductory level using the final average as the dependent variable and the advanced level using the final exam as the dependent variable.

In conclusion, the results revealed four significant relationships at the introductory level: between students' scores on the math quiz with their (1) final exam scores; (2) their final averages; (3) the Cognitive subscale of the SATS with their final exam scores; and (4) their final averages. These four significant relationships were also found at the advanced level. In addition, two more significant relationships were found between students' final average and the two subscales of Effort (5) and Affect (6). No relationship was found between students' scores on the admission math tests and both their final exam scores and their final averages i both the introductory and advanced level courses.

CHAPTER V

DISCUSSION

The purpose of this research was to determine the factors related to

students' achievements in both introductory and advanced statistics courses. Shau's

model adapted and adjusted to this study, to investigate the relationship between the

independent variables and the dependent variables, was expected to perform best in

predicting behavioral intention in business statistics students when a very explicit

situation-specific intention is investigated. Furthermore, to predict higher achievement in

students' performances or their intentions, not only were students' attitudes toward

statistics measured, but also their beliefs and evaluations related to their enrollment in

statistics courses, Therefore, in this study, the researcher included other factors such as

students' math skills represented by their scores on a quiz of simple math and on math admission exams.

Theoretically speaking the best possible answer to the research questions: (1) Do students' math scores in Lebanon admission exams have a relationship with students' performance in statistics courses? (2) Do students' attitudes toward statistics have a relationship with students' final scores on statistics courses? and (3) is there any difference in statistics course grades between students with high mathematical skills vs. students with low mathematical skills? is given by the goal-oriented Expectancy Value Theory. Behavior can be seen as a result of a student's expectancies, norms, and values a student experiences and the goal that the student formulates in a given academic course. It was expected by researchers that students choose the option that has the best possible combination of expected success and value. In terms of statistics education, most students are expected to choose to put in enough effort to pass the course (Shau, 2005). Highly motivated students put in more effort and strive for higher grades. Students that are more motivated usually see the future use of statistics in their jobs; they want to pursue a career in research and they have had a great deal of positive mathematics experiences in high school.

The difference between Schau's model (2005) and the model adjusted is that attitude in this study not only acts as an outcome variable, but part of it could also mediate the effect of individual factors on the student's 'final grade'. I expect this to be especially true for some of the subscales and discuss the relationship of the other variables with students' achievements as this constructs the model in this research.

The variables used in this study were students mathematical abilities to solve a simple math quiz, students' scores on the Lebanese admission exams called "official exams" and students' attitudes toward statistics measured by the survey of attitude toward statistics SATS. The researcher also examined more variables such as students' genders, GPA, students' own rates of their mathematical skills, and the number of years since they graduated from high school, and then tested their relationship with students' achievements. Students' achievements were divided into students' scores on the final exam and students' average in their course. This chapter provides a summary of the study, discussion of the findings, and recommendations for future research.

Summary

The Survey of Attitude toward Statistics (SATS) was used in this study to determine whether the attitude of the students toward statistics in Lebanon has a relationship with their achievement in statistics classes. Several articles discuss the attitudes of students toward statistics (Carmona, 2005; Shau, 2005; Vanhoef & Sotos, 2006). Other articles argued that students' negative attitudes toward statistics may have its roots in thinking that statistics is related to math (Ballard & Johnson, 2004; Johnson & Keunnen, 2006). However, this study found that only students' basic math skills and their attitude about intellectual knowledge were related to their performance in statistics courses. The SATS used in this study is made up of six subscales: (1) Affect, which contains the positive and negative feelings concerning statistics; (2) Cognitive Competence, which includes the students' attitudes about intellectual knowledge and skills when applied to statistics; (3) Value, which represents students' attitudes about the usefulness, relevance and worth of statistics; (4) Difficulty, which represents students' attitudes about the difficulty of

statistics as a subject; (5) Interest, which represents the interest of students in statistics; and finally (6) Effort, which represents how much effort students are willing to put forth in order to understand statistics.

A quiz of fifteen basic math questions was given to the students and adjusted to meet Lebanese students' level of mathematics performance. Finally, the scores on the math test in the Lebanese admission exams were tested to check if a relationship exists between the admission exams and the final achievement of Lebanese students in both introductory and advanced statistics courses. To maintain consistency in this research, the researcher made sure that all of the students completed the same homework problems during the semester and took the same final exam in the course. For the purposes of this study, the final exams in the introductory and advanced course were assumed equivalent.

Sample

Seven campuses consisting of fifteen sections (ten introductory and five advanced statistics courses) were included in this study; none of the sections was taught by the researcher. The sample consisted of 307 students in the introductory level courses and 260 students in the advanced level courses, most of them were males and they are between 19 and 30 years old.

Procedure

The questionnaire consisted of three parts. The first section consisted of twelve questions measuring students' characteristics, while the second section consisted of the SATS, and the third section consisted of a math quiz. The quiz consisted of 15 questions used to measure the students' basic mathematical skills. Attitudes toward

statistics were measured using the Survey of Attitudes toward Statistics (SATS) by

Shau. This survey instrument consisted of 48 items, 19 of which are reversed items,

based on a 7-point Likert scale that ranged from 1 for *strongly disagree* to 7 for

strongly agree and evaluated students' attitudes based on the subscales. Data collection

involved having participants complete the questionnaire during the last week of the

semester and writing an equivalent final exam prepared by the researcher.

Discussion of Major Findings

In the literature about statistics education, it is generally agreed that one

important source of achievement in statistics is previous experience in mathematics

(Johnson & Keunnen, 2006). Assuming the influence of a solid mathematical

background, the remaining question would be: Do Lebanese students need an extensive

math background to achieve in statistics? Therefore, in order to examine business

students' achievement in introductory and advanced statistics courses to better ascertain

the impact of both cognitive and non-cognitive factors on course performance, more

factors which include students' scores on the Lebanese math admission exams, and

their scores on a quiz of basic were investigated. Furthermore, this study provides

insight into Lebanese students' attitudes toward statistics and into the relationship

between their attitudes and their final achievements. However, another important

question would be: Which dimensions of attitudes toward statistics are more related to

their achievement?

The researcher found that the most important factor associated with student

performance was the SATS-Cognitive subscale in both final average and final exam

regardless of the level of the course. This is in line with previous research which stated

that a cognitive measure predicted statistics performance with slightly higher accuracy than the measure of attitudes toward quantitative concepts (Roberts & Bilderback, 1980). Moreover, a slight correlation existed between the students' final average in the introductory level and the rest of the subscales of the SATS; this correlation exists only with the final average and not with the final exam scores. This result was expected because it is in line with previous research (Chiesi & Primi, 2010) is that perceived competences and affect concurred in determining performance in statistics.

However, an interesting finding was the weak relationship between the attitudes about usefulness of statistics, difficulty, interest, effort and affect (SATS-Value, Difficulty, Affect, effort and interest) with the students' final achievement. In other studies, it was also found that these subscales are not related with statistics course performance (Carmona, 2005; Wise, 1985). In this point, researcher is in agreement with Gal and Ginsburg (1994) when they stated that:

> a student's responses to items assessing usefulness-of-statistics issues might have little to do with feelings or attitudes towards statistics as a subject; instead, they may only reflect the student's vocational development (Osipow 1973) or knowledge about requirements or content of certain jobs. (par. 25)

The analysis of each subscale separately showed that students in both courses thought statistics had its own value and had positive attitudes toward statistics. In addition to that, the students in the introductory course had higher perceived Cognitive Competence scores than the students in the advanced course. The distinguished difference between the two groups was the Effort subscale. There was a higher perceived effort in the advanced course than in the introductory course.

Furthermore, students in the introductory course valued statistics more than students in the advanced course. Thus, a higher positive attitude toward statistics appeared when students enrolled in their first statistics course. Although in the introductory course, students had higher positive attitudes towards learning statistics, both groups believed that statistics would be useless in professional life; this may be due to the lack of real life applications in statistics classes. Students in the introductory course were interested in studying statistics, and they were more likely to try to complete all of their assignments than students in the advanced course. However, the effort of students in the advanced course was higher than the introductory course; this may be due to the fact that advanced course actually requires more effort than the introductory one (e.g. more quizzes, a group project, and the use of SPSS).

Regarding the mathematical background of the students, the results of the study revealed that the mathematical knowledge acquired during high school, and measured in this study by the quiz of basic math, had a direct effect on achievement; a similar result appeared in Lalonde and Gardner in 1993. However, it appeared that these skills were needed in the final average for the students enrolled in the introductory level, and in the final exam for the students enrolled in the advanced level. This result may be due to the content of the courses.

It is not controversial that quantitative skills are important to success in introductory statistics. However, these results revealed that very basic mathematics skills are among the most important indicators of student success in a course where many of the skills directly assessed (such as analyzing data with descriptive statistics, hypothesis testing, or linear regression) are not necessarily of a basic skills nature. In contrast, the

researcher found that the math admission exams score (measuring higher mathematics skills such as algebra, geometry, and trigonometry) had no relationship to course performance. This means that basic mathematics skills are an important determinant of student success in statistics regardless of the level of mathematics presented.

The scores on the math quiz appeared to be significant only in the final exam of the advanced course and not related to the final average at the advanced level. This could be due to the absence of math at the advanced level in the assignments during the semester. The only need of math was in the final exam of the advanced course under investigation.

Although these results about the need of very basic math contradicted some studies which suggested that students exposed to more rigorous math coverage, especially more calculus, and more time spent on math in general (more credit hours of math), will perform better in their business statistics course (Green et al., 2009),this agrees with other studies (Ballard & Johnson, 2004; Johnson & Kuenenn, 2006) that revealed the need of only basic math to succeed in statistics courses.

If one linked these results to attitudes in statistics, it could be said that these results suggested that mathematical background has a strong association with the affective responses to statistics, especially the attitudes toward the statistics course, despite the valuing of statistics. The researcher thinks that previous experience in mathematics is a source of evaluation concerning self-perception in relation to statistics, but not of the more general assessment of statistics. In the researcher opinion, this is the reason for the significant relationship of final exam and final average results with SATS-Cognitive Competence but not with SATS-Difficulty. Although both subscales assess the

students` perception of the difficulty of statistics, SATS-Cognitive Competence subscale measures attitudes about their own intellectual knowledge and skills when applied to statistics, and SATS-Difficulty purpose is to evaluate the attitudes about the difficulty of statistics as a subject.

Descriptive analyses at both levels revealed that students have low achievement in the final average in both courses and in the final exam, but they achieved high in the math quiz and they have a higher positive attitude toward statistics in the SATS-Cognitive, Interest, Affect and Effort than Value and Difficulty. This is maybe due to a gap between statistics at high school and statistics at universities.

The results of the statistical analysis in both levels (Introductory and Advanced) reflected the results of the descriptive data. Analysis of the achievement data was performed by analysis of Regression Model which tested for correlations between students' statistics achievement and scores of students on a math quiz, admissions exams, and SATS.

First, as in previous studies reported in the second chapter of this dissertation, the researcher found a high internal consistency for the SATS. The test reliabilities were acceptable for the subscales and similar to the range of the reliabilities reported by previous studies (Shau, 2005).

Second, this study provides new descriptive data concerning students' attitudes toward statistics. These data are somewhat different from the trends mentioned in the literature. On one hand, at the introductory level, the attitude of Lebanese students about their intellectual knowledge and skills when applied to statistics affects their final average. The latter was not true when investigating the effect of this subscale at the

advanced level. This result contradicted studies that investigated the effect of this competence at the advanced level (Luh et al., 2004; Vanhoof & Sotos, 2006). The Cognitive competence was important in both levels when checking the final exam. On the other hand, the analysis of the other subscales scores reveals a relatively negative attitude toward the use of statistics in the students' field of study as compared to the scores of students from the bench-mark studies.

Third, the analysis of the relationship between the SATS scores and statistics final exams results in both levels correlates with findings obtained above regarding the final average, particularly, the Cognitive competence which was the only subscale related to final exam results.

Furthermore, while investigating the relative predictive value of (SATS) measures in predicting later final results, the data show no relationship between the attitudes toward the intellectual knowledge and skills when applied to statistics after experiencing an introductory statistics course (Cognitive Subscale), but this subscale has a relationship with both levels in the final statistics exam results. This finding is similar to the findings of Roberts and Bilderback (1980), namely that a cognitive measure predicted statistics performance in an introductory level with slightly higher accuracy in exam results. However, this difference between the prediction of the final average and the final exam in the advanced level is smaller than the relation with the introductory level. In fact, the relationship for the cognitive subscale is even slightly (and significantly) higher in the introductory level than the relationship for the cognitive measure in the advanced level. These results are an important indicator of the essential role attitudes toward statistics (besides cognitive characteristics) play for the development of statistical competence.

Fourth, it was remarkable that there is only a relationship between the subscales, Value, Affect and Effort with the final average in the advanced level and not in the introductory level. These results suggest that students who recognize the importance of statistics for their field of study (in the case of the present study: senior students) tend to achieve better. In addition, they have a higher positive feeling toward statistics since they already experienced statistics in the introductory level; thus, they tend to put in more effort in order to achieve better in their course.

Finally, an innovative element in this study is that it also yields findings concerning the analysis of the relationship between students' scores on the Lebanese admissions math exams and students' final achievement in the courses. As to the advanced level results, these scores are highly associated with the final exam score; they have no relationship at all with the final exam in the introductory level and no relationship with the final average in both levels. These results suggest that Lebanese admissions exams have no relationship with the achievement of students in the statistics courses. The researcher expected these results since there is no statistics in those exams and the students are not willing to study statistics in order to pass the Lebanese admissions tests.

Although the Lebanese admissions exams are at higher levels in mathematics than the SAT in the United States, the results can still contradict other studies reflecting the positive correlation between SAT and student achievement in statistics courses (Ballard & Johnson, 2004; Johnson & Keunnen, 2006). Taken as a whole, the present research offers some greater insight into helping forecast students who are likely to encounter difficulties in statistics courses. Administering the set of instruments mentioned above,

students who are struggling with the course and need extra help could be identified. It would be possible to help them in the beginning of the course before they drop the class or fail the examination.

Specifically results suggest the need to improve students' mathematical skills and their attitudes toward statistics in order to reduce their level of anxiety toward this discipline. This goal can be attained through fostering mathematical skills. This would start with the assumption that working on mathematical skills will have a positive effect on attitudes toward statistics (Lalonde & Gardner, 1993) and on anxiety when dealing with statistics (Gal et al., 1997; Onwuegbuzie, 2003; Sorge & Schau, 2002). Increasing mathematical competence of students will improve achievement in statistics not only directly, but also indirectly because students who are confident in their mathematical abilities develop a positive attitude and experiences less anxiety.

This study offers some suggestions that can be helpful to prevent learning difficulties, to reduce time necessary to pass the examination and to improve the level of performance with statistics.

<center>Limitations</center>

Although the present research highlights the relationship of several factors with student performance, it features a number of limitations.

First of all; this study assessed student performance on the basis of a single Lebanese university. The research was limited to one semester; therefore the findings cannot be generalized to all Lebanese universities which vary in mission, size, and selectivity.

Second, we do not know if during the length of a course, students became more or less sensitive to the effect of the teacher. Therefore, the teacher's impact of the learning process may be a task label where it might be affecting the results.

Third, the spread of user-friendly statistical software in the last few decades has reduced the importance of mastering computation skills and mathematic formalization up to an intermediate level of statistical education. For instance, the advanced level could have one assignment using SPSS, which could make a difference in the final average scores of the students in the course.

Fourth, the design of instructional materials and exercises for regular academic courses at the practical level and the method used by instructors could not be controlled during the learning process; however, the researcher controlled the midterm, the exercises recommended for assignments and the final exams.

Some other general limitations of this study should be kept in mind in interpreting these findings. The use of mathematics admissions scores and the scores on the math quiz as measures of prior mathematics achievement raised concerns that these scores were confounded since they may both be related to the Lebanese curriculum. How much math did those students actually learn in high school? My analyses that used the admissions scores provided evidence that scores on the math quiz did not affect the scores on admissions mathematics tests in ways that would bias inferences. The researcher cannot be certain that such confounding has been completely removed.

Recommendations

The researcher suggests the implementation of the following recommendations at the institution where this research was conducted and maybe at all educational

institutions in Lebanon. The basic-math-quiz variable and the results of SATS can help

us to identify the students most in need of help in statistics. Furthermore, the basic

mathematics skills and attitudes toward statistics that these variables measured may be

the ones that can be most easily addressed in statistics courses.

Recommendations for Policy or Practice

What should the Lebanese Ministry of Education do? This study finds no significant

relationship between students' scores on the mathematics portion of the admission exams

and performance in statistics. This stands in contrast to the importance of the basic math

quiz score. This finding may have implications for universities that rely solely on

admissions exams to enroll students in universities. However, whether the math

admissions exams fail to accurately assess the basic mathematics skills identified in this

study merits further analysis. This result signals that the Lebanese ministry of education

should include more statistics in the curriculum at all levels and consequently include

statistical questions in the admissions exams. This might help students improve their

negative attitudes toward statistics since they will be more familiar with statistics. They

will have a more open mind when they start a statistics course. Because they know what

to expect, they feel more competent and, therefore, they will probably obtain a better

grade.

What should the Lebanese Universities do? Introductory statistics is commonly a

prerequisite course for students in many programs of study. Thus, universities and

colleges looking to improve student performance and retention should take a careful look

at what the necessary prerequisites for introductory statistics should be, and how course

prerequisites are enforced. In particular, Lebanese universities, which do not require any

prerequisite math courses, should be looked at. Also, Lebanese universities rely on admissions exams which apparently have no significance to students; Lebanese universities should begin using placement math exams that contain the basic mathematics skills needed to prepare students for statistics classes. Thus, students scoring poorly on a mathematics placement exam should be required to complete a developmental level mathematics course prior to taking introductory statistics. Furthermore, universities should rely on the present research which helps to identify the particular mathematics skills that are important to emphasize in the prerequisites for introductory statistics. Universities should be sure that mathematics placement exams that are used for statistics course prerequisites assess basic math skills, including understanding simple equations, ratios and area.

Class size and teaching quality. Although class size and teaching quality was not examined in this study but as a teacher, the researcher would like to teach a class with only a handful of motivated students who are eager to learn and work in collaboration to complete this course (Garfield, 2003). However, reality is different, class sizes smaller than 15 students would be beneficial to student achievement. Keeping group size as small as possible is still recommended for better interaction, motivation and communication.

The quality of teaching should also be taken into account, regardless of group size. Therefore, the researcher emphasizes that keeping track of teaching quality is important, which can be done in future research, particularly in Lebanon, where the statistics instructors are often not statistics majors. Most of them come from a business and economic background.

Interaction and motivation are the keywords in statistics teaching. The teacher and the students should interact as much as possible. This can be achieved by means of lectures, discussions, group work, individual appointments, class exercises and presentations. Methods like these could improve statistics education. Although a lot has already been done to improve the quality of techniques used for teaching statistics, the use of interactive teaching methods, along with questions and answers during class meetings will allow students to discuss topics, ask and answer each other's questions, and make and discuss class exercises.

Instructors should pay special attention to the mathematics skills needed to master the statistics concepts they are teaching. One possibility is to include reviews of math concepts prior to introducing the related statistics concept. While adding additional in-class content to the course is costly - other options can be considered, such as making use of online mathematics reviews that have to be completed by the students outside of class as a requirement for the course.

Lastly, teachers should inform students at the start of the semester of the expectations, by means of a good course manual. Being informed about the expectations will take away some of the uncertainty and anxiety from the learning process. This can also be the basis for a 'well-informed expectation' of course outcomes and a well aimed work ethic (Svanum & Bigatti, 2006).

How can we change their attitudes? 'Statistics anxiety' is experienced almost without exception, so this question is difficult to answer. Continuous assessment makes students aware of the fact that not only the final exam counts, but it also includes class exercises, homework, presentations, active participation, and (group) papers and software

applications. This will ensure that the students' anxiety is not because of the final exam, but is eased and spread out (Garfield, 1994). An example is the use of 'real-life projects' that teach students how to conduct real-life research and make them acquainted with all possibilities and constraints of the research process. Those projects can be done using statistical software to teach students that statistics is not only mathematical calculations but also can be done using technology. In order to make the material seem more alive even if classes are fairly large, use of cooperative learning techniques, such as group work during class meetings can enhance the attitudes of students (Magel, 1998).

What can students do themselves? First of all, being uninformed does not help much. Reading course manuals and asking the teacher about the expectations of the course would already help a great deal for student development of well-informed expectations. Also, students should help each other. Peer assessment methods actively involve students in their own assessment. It is a form of collaborative learning. It helps students get involved with each other for their own learning (Dochy, Segers, & Sluijsmans, 1999). For example, if they make mistakes, they would rather hear that from each other than from the teacher. During student projects, the group work should be evaluated separately for this purpose. They should not take all the information for granted, and they should be critical. The students should not be afraid to give the wrong answer for once! Lastly, with the help of their instructor, students should develop statistical skills that are based on critical insight, not on recollection, and thus they should have an overview rather than a narrow view of the use of statistics.

Recommendations for future research

The vast number of research questions that result from this project cannot be left unnoticed, and a number of recommendations are made. After all, good empirical research raises more questions than it answers.

The first question that is derived from these research results is about the nature, position and operation of Cognitive-competence in the model used in this study. The cognitive competence could be split up into a deep and a surface learning approach (Tempelaar, Schim van der Loeff, Gijselaers, 2007). The operational approach can be considered in terms of the academic work ethic. Therefore, the special place of the Cognitive subscale in the SATS can be a topic for future research.

A second important question could be the effect of Lebanese admissions scores on the achievement of students at universities. This future research may contribute to the understanding of statistics achievement at universities. Analytical approaches that usually constitute education help students develop their views, so there is a need to plan and conduct research and draw the right conclusions.

Also, one important factor has been left out of this study: the evaluation of teaching quality. Teaching methods, group size, and course duration all have a diffuse effect on student achievement. But the method used by the instructor is assumed to determine attitudes, student motivation and student achievement.

Unfortunately, no information about the evaluation of teaching quality was available for this study, mostly for ethical reasons. However, it is assumed that the evaluation of the teacher is taken into consideration when a student constructs his own attitudes, motivation, and expectations. Therefore, it is expected that teaching quality plays an important role in student motivation to learn and in student achievement.

A future study about the effects on student achievement should have a longitudinal set-up with multiple measurements in time to make sure the development over time is evaluated well. Expectations are that when questioned at a later point in time, a student's attitude will reflect the true value, interest and affect for statistics at a greater level than before he took the course.

Lastly, more institutions could be added to the sample to enable a multilevel approach to the analysis. By using a multilevel approach, the nested nature of this type of data can be truly acknowledged.

APPENDIX A

QUESTIONNAIRE

Dear Student,

The purpose of this study is to examine the factors affecting student's final grade in Statistics courses.

Please take a few minutes to answer the following questions.

The survey is going to be kept CONFIDENTIAL.

I.   **Demographics:**

1. ID number:--

2. What is your gender?
    1. Male
    2. Female

3. How many semesters have you attended at your University? ------------------------

4. In which year did you graduate from High school? ---------------------------------

5. How many hours per week do you access the internet? ---------------------------

6. What is your age? ---

7. On a scale of 1-10 how would you rate your Math skills? With 1 as low and 10 as

    perfect: -------------------------------------

8. What is your cumulative GPA in the last semester? ------------------------------------

9. On average, how often do you seek help from your statistics instructor outside the
    class (office hours, e-mails, blackboard discussion)?

    1. Never
    2. Rarely
    3. Sometimes
    4. Often

10. What was your official exams MATH score? --

11. Since graduating from high school, how many Math courses did you completed? -

    ----

12. List the Math courses you took before this course:-------------------------------------

    ----

II. Survey of Attitudes Toward Statistics

DIRECTIONS: The statements below are designed to identify your attitudes about statistics. Each item has 7 possible responses. The responses range from 1 (strongly disagree) through 4 (neither disagree nor agree) to 7 (strongly agree). If you have no opinion, choose response 4. Please read each statement. Mark the <u>one</u> response that most clearly represents your degree of agreement or disagreement with that statement. Try not to think too deeply about each response. Record your answer and move quickly to the next item. Please respond to all of the statements.

	Strongly disagree			Neither disagree nor agree			Strongly agree
1. I tried to complete all of my statistics assignments.	1	2	3	4	5	6	7
2. I worked hard in my statistics course.	1	2	3	4	5	6	7
3. I like statistics.	1	2	3	4	5	6	7
4. I feel insecure when I have to do statistics problems.	1	2	3	4	5	6	7
5. I have trouble understanding statistics because of how I think.	1	2	3	4	5	6	7
6. Statistics formulas are easy to understand.	1	2	3	4	5	6	7
7. Statistics is worthless.	1	2	3	4	5	6	7
8. Statistics is a complicated subject.	1	2	3	4	5	6	7
9. Statistics should be a required part of my professional training.	1	2	3	4	5	6	7
10. Statistical skills will make me more employable.	1	2	3	4	5	6	7
11. I have no idea of what's going on in this statistics course.	1	2	3	4	5	6	7
12. I am interested in being able to communicate statistical information to others.	1	2	3	4	5	6	7

	Strongly disagree			Neither disagree nor agree			Strongly agree
13. Statistics is not useful to the typical professional.	1	2	3	4	5	6	7
14. I tried to study hard for every statistics test.	1	2	3	4	5	6	7
15. I get frustrated going over statistics tests in class.	1	2	3	4	5	6	7
16. Statistical thinking is not applicable in my life outside my job.	1	2	3	4	5	6	7
17. I use statistics in my everyday life	1	2	3	4	5	6	7
18. I am under stress during statistics class.	1	2	3	4	5	6	7
19. I enjoy taking statistics courses.	1	2	3	4	5	6	7
20. I am interested in using statistics.	1	2	3	4	5	6	7
21. Statistics conclusions are rarely presented in everyday life.	1	2	3	4	5	6	7
22. Statistics is a subject quickly learned by most people.	1	2	3	4	5	6	7
23. I am interested in understanding statistical information.	1	2	3	4	5	6	7
24. Learning statistics requires a great deal of discipline.	1	2	3	4	5	6	7
25. I will have no application for statistics in my profession.	1	2	3	4	5	6	7
26. I make a lot of math errors in statistics.	1	2	3	4	5	6	7
27. I tried to attend every statistics class session.	1	2	3	4	5	6	7
28. I am scared by statistics.	1	2	3	4	5	6	7

	Strongly disagree			Neither disagree nor agree			Strongly agree
29. I am interested in learning statistics.	1	2	3	4	5	6	7
30. Statistics involves massive computations.	1	2	3	4	5	6	7
31. I can learn statistics.	1	2	3	4	5	6	7
32. I understand statistics equations.	1	2	3	4	5	6	7
33. Statistics is irrelevant in my life.	1	2	3	4	5	6	7
34. Statistics is highly technical.	1	2	3	4	5	6	7
35. I find it difficult to understand statistical concepts.	1	2	3	4	5	6	7
36. Most people have to learn a new way of thinking to do statistics.	1	2	3	4	5	6	7

NOTICE that the labels for the scale on each of the following items differ from those used above.

37. How good at mathematics are you?	Very poor 1	2	3	4	5	6	Very good 7
38. In the field in which you hope to be employed when you finish school, how much will you use statistics?	Not at all 1	2	3	4	5	6	Great deal 7
39. How confident are you that you have mastered introductory statistics material?	Not at all confident 1	2	3	4	5	6	Very confident 7
40. As you complete the remainder of your degree program, how much will you use statistics?	Not at all 1	2	3	4	5	6	Great deal 7
41. If you could, how likely is it that you would choose to take another course in statistics?	Not at all likely 1	2	3	4	5	6	Very likely 7

42. How difficult for you is the material currently being covered in this course?

	Very easy						Very difficult
	1	2	3	4	5	6	7

DIRECTIONS: For each of the following statements mark the one best response. Notice that the response scale changes on each item.

43. Do you know definitely what grade you will receive in this course?

        1. Yes   2. No

44. What grade do you expect to receive in this course?

1. A	5. B-	9. D
2. A-	6. C+	10. F
3. B+	7. C	
4. B	8. D+	

45. In a usual week, how many hours did you spend outside of class studying Statistics? Give only one single numeric response that is a whole number

_____

46. In the past week, how would you describe your overall stress level?

	Very low						Very high
	1	2	3	4	5	6	7

THANKS FOR YOUR HELP!
Please Proceed to the Math Quiz

III. Mathematics Quiz

Answer the following mathematics questions to the best of your ability. Please do not use a calculator; you have 20 minutes to complete this Quiz, **No Need** for justification.

1. Solve the following system of equations for the pair $(x;y)$:

    x = y - 6
    y = 10 + 3x

(a) (-6, 0) (b) (-2, 4)   (c) (2,-4)   (d) (0, 10) (e) (-6, 0)

2. Find the value of x :

$$\frac{5}{2x-3}=\frac{3}{x+5}$$

(a) 43 (b) 34 (c) 34/11   (d) 11/34   (e) none of the above

3. Suppose that $x = \dfrac{a}{b}$. Then if $x = 4$ and $a = 8$, solve for b.

(a) 1   (b) 2   (c) 32   (d) 4   (e) 1/2

4. Perform the following division: $x = \dfrac{\frac{1}{2}}{\frac{2}{3}}$

(a) 3   (b) 3/2   (c) 3/4   (d) 4/3   (e) 1/3

5. Find the value of : $\sqrt[4]{\sqrt{3^{12}}} - \sqrt{27}$

(a) 0   (b) $\sqrt{27}$ (c) $\sqrt{3^{12}}$ (d) $\sqrt{12}$ (e) 27

6. Simplify : $\left(\left(\frac{16}{9}\right)^4\right)^{\frac{1}{8}}$

(a) $\frac{3}{4}$ (b) $\frac{4}{3}$ (c) $\frac{16}{9}$ (d) $\frac{2}{3}$ (e) $\frac{3}{2}$

7. Find the area of the triangle drawn below.
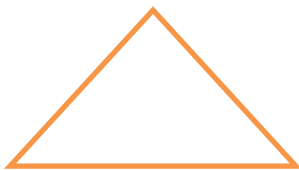
The lengths of sides are: a = 6, b = 4 and c = 4.   The area of the triangle is:

(a)   3   (b) 4   (c) $\sqrt{7}$ (d) $3\sqrt{7}$ (e) $\sqrt{52}$
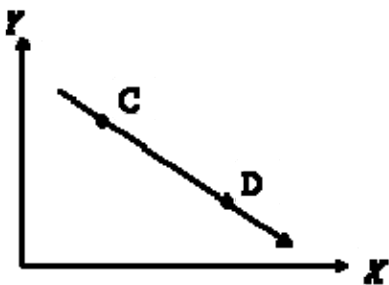
8.
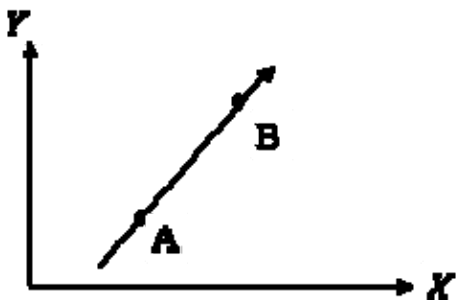
The coordinates of point A are (1, 2) and the coordinates of point B are
(2, 4).   Find the slope of the line.

(a) 1/2   (b) 1   (c) -1   (d)   2   (e)   -2

9.

The coordinates of point C are (1, 4) and the coordinates of point D are

   (5, 2).   Find the slope of the line.

(a)   1/2   (b) -1/2   (c) 2   (d) -2   (e) 5/4

10. Suppose you want to carpet a rectangular room that is 3m by 6m.
Carpet costs $10 per square meter.
How much does it cost to carpet the room?

(a) $1800   (b) $180   (c) $450   (d) $90   (e) $9

11. The fraction 13/38 is approximately

(a) 0.15   (b) 0.25   (c) 0.35   (d) 0.45   (e) 0.55

12. The square root of 100,000 is about

(a) 30   (b) 100   (c) 300   (d) 1,000   (e) 3,000

13.   In a group of 900 voters, two-thirds said they would vote for
a specific person in the race for deputy. How many of the 900
voters said they would vote for the deputy?

(a) 200   (b) 300 (c) 330   (d) 600   (e) 660

14.   In 2005, a total of 3,000 students were enrolled at LIU
University. In 2006, the corresponding figure was 3300.
What is the percent increase in the number of students from 2005 to
2006?

(a) 1%   (b) 3%   (c) 10% (d) 30% (e) 33%

15.   What is 80% of 60?

(a) 24   (b) 36   (c) 40   (d) 48   (e) 50

Thank you for your time

APPENDIX B

PERCENTAGES OF STUDENTS INCORRECT ANSWERS ON THE MATH QUIZ

Answer the following mathematics questions to the best of your ability. Please do not use a calculator.

1.   Solve the following system of equations for x:

   $x = y - 6$

   $y = 10+3x$

      (a) (-6, 0) (b) (-2, 4)   (c) (2,-4)   (d) (0, 10) (e) (-6, 0)

      The results showed that 13.3% of students in the introductory course answered this question incorrectly while 12.6% of students in the advanced course answered this question incorrectly

2.   Find the value of x:

$$\frac{5}{2x-3} = \frac{3}{x+5}$$

   (a) 43 (b) 34   (c) 34/11   (d) 11/34   (e) none of the above

   The results showed that 12.4% of students in the introductory course answered this question incorrectly while 12.9% of students in the advanced course answered this question incorrectly

3.   Suppose that $x = \frac{a}{b}$. Then if $x = 4$ and $a = 8$, solve for b.

   (a) 1   (b) 2   (c) 32   (d) 4   (e) 1/2

   The results showed that 14.8% of students in the introductory course answered this question incorrectly while 10.2% of students in the advanced course answered this question incorrectly.

4. Perform the following division: $x = \dfrac{{}^{1}\!/_{2}}{{}^{2}\!/_{3}}$

   (a) 3   (b) 3/2   (c) 3/4   (d) 4/3 (e) 1/3

   The results showed that 18.1% of students in the introductory course answered this question incorrectly while 11.7% of students in the advanced course answered this question incorrectly

5. Find the value of : $\sqrt[4]{\sqrt{3^{12}}} - \sqrt{27}$

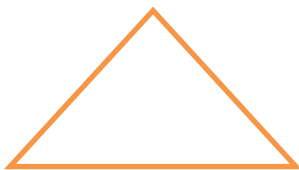   (a) 0   (b) $\sqrt{27}$ (c) $\sqrt{3^{12}}$ (d) $\sqrt{12}$ (e) 27

   The results showed that 26.8% of students in the introductory course answered this question incorrectly while 20.6% of students in the advanced course answered this question incorrectly

6. Simplify : $\left(\left(\dfrac{16}{9}\right)^{4}\right)^{\frac{1}{8}}$

   (b) ${}^{3}\!/_{4}$ (b) ${}^{4}\!/_{3}$ (c) ${}^{16}\!/_{9}$ (d) ${}^{2}\!/_{3}$ (e) ${}^{3}\!/_{2}$

   The results showed that 19.8% of students in the introductory course answered this question incorrectly while 14.7% of students in the advanced course answered this question incorrectly

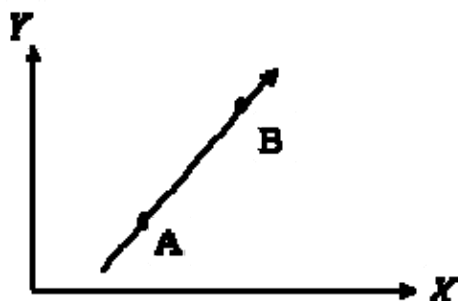7. Find the area of the triangle drawn below.

The lengths of sides are: a = 6, b = 4 and c = 4.

The area of the triangle is :(a) 3   (b) 4   (c) $\sqrt{7}$ (d) $3\sqrt{7}$ (e) $\sqrt{52}$

Table 5 (continued)

The results showed that 33% of students in the introductory course answered this question incorrectly while 33.5% of students in the advanced course answered this question incorrectly

8.

The coordinates of point A are (1, 2) and the coordinates of point B are

(2, 4) Find the slope of the line.

(a) 1/2   (b) 1   (c) -1 (d) 2   (e) -2

The results showed that 21.8% of students in the introductory course answered this question incorrectly while 19.1% of students in the advanced course answered this question incorrectly

9.
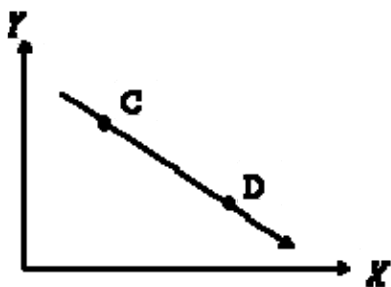
The coordinates of point C are (1, 4) and the coordinates of point D are (5, 2) Find the slope of the line.

(a) 1/2   (b) -1/2   (c) 2   (d) -2   (e) 5/4

The results showed that 16.7% of students in the introductory course answered this question incorrectly while 19.6% of students in the advanced course answered this question incorrectly

10.   Suppose you want to carpet a rectangular room that is 3m by 6m. Carpet costs $10 per square meter. How much does it cost to carpet the room?

(a) $1800 (b) $180 (c) $450 (d) $90 (e) $9

The results showed that 13% of students in the introductory course answered this question incorrectly while 13.5% of students in the advanced course answered this question incorrectly

11.   The fraction 13/38 is approximately

(a) 0.15   (b) 0.25   (c) 0.35   (d) 0.45   (e) 0.55

The results showed that 15.7% of students in the introductory course answered this question incorrectly while 13.8% of students in the advanced course answered this question incorrectly

12.   The square root of 100,000 is about

(a) 30   (b) 100   (c) 300 (d) 1,000 (e) 3,000

The results showed that 27% of students in the introductory course answered this question incorrectly while 31.3% of students in the advanced course answered this question incorrectly

13.   In a group of 900 voters, two-thirds said they would vote for a specific person in the race for deputy. How <u>many</u> of the 900 voters said they would vote for the deputy?

 (a) 200   (b) 300 (c) 330   (d) 600   (e) 660

The results showed that 16.7% of students in the introductory course answered this question incorrectly while 14.4% of students in the advanced course answered this question incorrectly

14.   In 2005, a total of 3,000 students were enrolled at LIU University. In 2006, the corresponding figure was 3300. What is the percent increase in the number of students from 2005 to 2006?

(a) 1%   (b) 3%   (c) 10% (d) 30% (e) 33%

The results showed that 24.4% of students in the introductory course answered this question incorrectly while 19.1% of students in the advanced course answered this question incorrectly

15.   What is 80% of 60?

(a) 24   (b) 36   (c) 40   (d) 48   (e) 50

The results showed that 11.6% of students in the introductory course answered this question incorrectly while 17% of students in the advanced course answered this question incorrectly.

APPENDIX C

THE LEBANESE INTERNATIONAL UNIVERSITY

AUTHORIZATION TO PARTICIPATE IN RESEARCH PROJECT

Consent is hereby given to participate in the study titled:

FACTORS AFFECTING STUDENT'S PERFORMANCE IN STATISTICS COURSES IN LEBANON

Dear Mrs.Hiba Naccache,

After Reviewing your proposal to conduct the study under the title mentioned above, and after a discussion with the Lebanese International University board of trustee,

I , the vice President for Administration and Finance in the Lebanese International University, with the permission of Provost, hereby accept to conduct this study and collect data at all the campuses of LIU.

Signatures:

Signature of the Vice President for Administration and Finance ------*Samir abou Nassif.PhD*---

Date-------15/2/2011--------------------

Signature of Provost ----------------------*Ali Tarabay, PhD*

Date----16/2/2011--------------------

Signature of the Person Explaining the Study -----*Hiba Naccache* --------------------
----

Date----27/2/2011-------------------

APPENDIX D

AUTHORIZATION TO USE THE SATS

June 10, 2011

Dear Hiba Naccache,

On November 19, 2010, I e-mailed you permission to use the SATS-36© free for one year. If you need to continue using it, I asked you to contact me again.

Congratulations on being close to defending your proposal. I wish you the best.

Candace

APPENDIX E

AUTHORIZATION TO USE THE MATH QUIZ

Dear Ms. Naccache,

I am happy for you to use a version of the math quiz that I used for my paper in *Journal of Economic Education*, as long as you cite appropriately. I am copying this message to my co-author, Marianne Johnson.

Yes, I would be interested to see your results. Good luck with your work.

Charley Ballard

Charles L. Ballard

Department of Economics

Michigan State University

Marshall-Adams Hall

East Lansing, MI 48824-1038

517.353.2961

I am also happy for you to use the quiz. Good luck with your project!

Marianne Johnson

Marianne Johnson
Professor of Economics
College of Business
University of Wisconsin Oshkosh
(920) 424-2230

APPENDIX E

IRB APPROVAL FORM

THE UNIVERSITY OF SOUTHERN MISSISSIPPI.

INSTITUTIONAL REVIEW BOARD
118 College Drive #5147 | Hattiesburg, MS 39406-0001
Phone: 601.266.6820 | Fax: 601.266.4377 | www.usm.edu/irb

NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi
Institutional Review Board in accordance with Federal Drug Administration
regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR
Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for
  monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of
  subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable
  subjects.
- Any unanticipated, serious, or continuing problems encountered regarding
  risks to subjects must be reported immediately, but not later than 10 days
  following the event. This should be reported to the IRB Office via the
  "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months.
  Projects that exceed this period must submit an application for renewal or
  continuation.

PROTOCOL NUMBER: **R11032233**
PROJECT TITLE**: Factors Related to Students' Performance
                in Statistics Courses in Lebanon**
PROJECT TYPE**: Renewal of a Previously Approved Project**
RESEARCHER/S**: Hiba Naccache**
COLLEGE/DIVISION**: College of Science & Technology**
DEPARTMENT: **Center of Math Education CSME**
FUNDING AGENCY: **N/A**
IRB COMMITTEE ACTION**: Expedited Review Approval**
PERIOD OF PROJECT APPROVAL: **05/09/2012 or 05/09/2013**

Lawrence A. Hosman, Ph.D.
Institutional Review Board Chair

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