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The Experience of Teaching Statistics to Non-specialist Students in Saudi Universities

Abdullah Mohammed Alomir

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School of Mathematics and Statistics

University of Glasgow

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Abstract

Undoubtedly, statistics has become one of the most important subjects in the modern world, where its applications are ubiquitous. The importance of statistics is not limited to statisticians, but also impacts upon non-statisticians who have to use statistics within their own disciplines. Several studies have indicated that most of the academic departments around the world have realized the importance of statistics to non-specialist students. Therefore, the number of students enrolled in statistics courses has vastly increased, coming from a variety of disciplines. Consequently, research within the scope of statistics education has been able to develop throughout the last few years.

One important issue is how statistics is best taught to, and learned by, non-specialist students. This issue is controlled by several factors that affect the learning and teaching of statistics to non-specialist students, such as the use of technology, the role of the English language (especially for those whose first language is not English), the effectiveness of statistics teachers and their approach towards teaching statistics courses, students' motivation to learn statistics and the relevance of statistics courses to the main subjects of non-specialist students. Several studies, focused on aspects of learning and teaching statistics, have been conducted in different countries around the world, particularly in Western countries. Conversely, the situation in Arab countries, especially in Saudi Arabia, is different; here, there is very little research in this scope, and what there is does not meet the needs of those countries towards the development of learning and teaching statistics to non-specialist students. This research was instituted in order to develop the field of statistics education.

The purpose of this mixed methods study was to generate new insights into this subject by investigating how statistics courses are currently taught to non-specialist students in Saudi universities. Hence, this study will contribute towards filling the knowledge gap that exists in Saudi Arabia. This study used multiple data collection approaches, including questionnaire surveys from 1053 non-specialist students who had completed at least one statistics course in different colleges of the universities in Saudi Arabia. These surveys were followed up with qualitative data collected via semi-structured interviews with 16 teachers of statistics from colleges within all six universities where statistics is taught to non-specialist students in Saudi Arabia's Eastern Region.

The data from questionnaires included several types, so different techniques were used in analysis. Descriptive statistics were used to identify the demographic characteristics

of the participants. The chi-square test was used to determine associations between variables. Based on the main issues that are raised from literature review, the questions (items scales) were grouped and five key groups of questions were obtained which are: 1) Effectiveness of Teachers; 2) English Language; 3) Relevance of Course; 4) Student Engagement; 5) Using Technology. Exploratory data analysis was used to explore these issues in more detail. Furthermore, with the existence of clustering in the data (students within departments within colleges, within universities), multilevel generalized linear models for dichotomous analysis have been used to clarify the effects of clustering at those levels. Factor analysis was conducted confirming the dimension reduction of variables (items scales).

The data from teachers' interviews were analysed on an individual basis. The responses were assigned to one of the eight themes that emerged from within the data: 1) the lack of students' motivation to learn statistics; 2) students' participation; 3) students' assessment; 4) the effective use of technology; 5) the level of previous mathematical and statistical skills of non-specialist students; 6) the English language ability of non-specialist students; 7) the need for extra time for teaching and learning statistics; and 8) the role of administrators.

All the data from students and teachers indicated that the situation of learning and teaching statistics to non-specialist students in Saudi universities needs to be improved in order to meet the needs of those students. The findings of this study suggested a weakness in the use of statistical software applications in these courses. This study showed that there is lack of application of technology such as statistical software programs in these courses, which would allow non-specialist students to consolidate their knowledge. The results also indicated that English language is considered one of the main challenges in learning and teaching statistics, particularly in institutions where English is not used as the main language. Moreover, the weakness of mathematical skills of students is considered another major challenge. Additionally, the results indicated that there was a need to tailor statistics courses to the needs of non-specialist students based on their main subjects. The findings indicate that statistics teachers need to choose appropriate methods when teaching statistics courses.

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Chapter 1. Introduction

1.1. Background of the study

With the emergence of the importance of statistics and its development as an independent discipline, the number of people who are interested in the subject has increased. The need to learn statistics is not limited only to statisticians, but also includes non-statisticians in various disciplines who use statistics within their fields. Several studies report that the number of students who enrol in statistics courses is increasing; students come from different disciplines within universities (Garfield & Ben-Zvi 2008; Scheaffer & Stasny 2004). Unfortunately, several factors related to students experiences of learning and teaching statistics have led to the emergence of the idea that statistics is difficult and not an important subject among non-specialist students; many studies have identified this trend, including Reid & Petocz (2002) and Moore (2001).

Not infrequently, introductory statistics courses are taught by teachers whose specialism is not statistics. Anecdotal evidence suggests that these teachers usually focus on the formulas and computational aspects of the subject rather than the application of statistics, which leads them to present the topics of statistics as mathematical. Understanding statistical concepts, improving the statistical thinking of students, increasing students' motivation toward statistics and providing students with the skills they need in their future should be considered the main goals of teachers in teaching statistics courses to non-specialist students (Garfield et al. 2008; Harkness, Lane & Harwood 2003; Pieraccini 1990; Schuyten 1990; Snee 1990). However, those teachers must select appropriate methods for teaching statistics in order to achieve these goals (Greer 2001).

One of the difficulties facing statistics teachers is the diversity of students' disciplines where those students are trying to get what they need for their disciplines from statistics courses. The failure of students to reach this goal promotes the idea that statistics courses are not relevant to their main subjects and are unimportant (Simpson 1995). In addition, the content of the courses, examples and data used, tutorials and assignments should be relevant to the main subjects of non-specialist students (Bradstreet 1996; Everson, Zieffler & Garfield 2008; Simpson 1995).

Currently, technology has become a key element in the process of education. Several studies revealed that technology played a crucial role in the achievement of students' performance (Li 2003; Ringstaff & Kelley 2002). In statistics, technology has a significant impact and statistical software programs have helped analysts to perform complex statistical operations and analysis on large data sets more rapidly. Therefore, a student's ability to deal with statistical software programs is considered one the most important goals in statistics courses, particularly for non-specialist students (Biehler 1997, Chance, Ben-Zvi, Garfield & Medina 2007; Everson & Garfield 2008; Tishkovskaya & Lancaster 2012). However, use of technology is not without obstacles encountered by both teachers and students (Callingham 2011; Chance et al. 2007).

The English language is one of the factors that affects the learning of statistics particularly where non-English Speaking Background students (NESB) who have limited language skills are concerned. Those students may find statistical software programs difficult to use as most of them are designed in English. Furthermore, non-specialist students may be confused with the statistics terminology, particularly if their main language is not English; this is compounded in cases where terms have no equivalent translation to other languages, such as Arabic. However, this issue not only occurs in countries where the main language is not English, but may also happen in countries that use English as the main language, where these countries are the destination of international students. Therefore, teachers of statistics courses should pay attention to potential language difficulties (Abdelbasit 2010; Coutis & Wood 2002; Kaplan, Fisher & Rogness 2009; Rienties, Beausaert, Grohnert, Niemantsverdriet, & Kommers 2012).

Research on the main problems facing students in the field of statistics education, particularly in learning and teaching statistics, has been considerable over the past twenty years and the numbers of research studies that are conducted are increasing around the world (Becker 1996; Garfield & Ben-Zvi 2007). These studies offer valuable suggestions for teachers to improve their teaching methods where non-specialist students are learning statistics.

1.2. Research problem

With the development of research in statistics education, studies have determined the obstacles and difficulties in learning and teaching statistics to non-specialists in different countries around the world. Such research assists teachers to overcome these difficulties and help students to meet their statistical needs from each course. Furthermore, the research on statistics education has reached an advanced stage in several countires, especially Western countries such as the United Kingdom and the United States where researchers have covered many aspects of this discipline. In spite of these developments, there has been little research on statistics education, particularly in terms of learning and teaching statistics courses in Arab countries (Innabi 2014). Additionally, to the knowledge of the researcher, no studies about learning and teaching statistics to non-specialist students have been conducted in Saudi Arabia. Therefore the most important step is to identify the current situation regarding teaching statistics courses to non-specialist students in Saudi universities, then focus on the strengths and weaknesses of these educational models in order to improve research and practice. Therefore, the purpose of the present study is to generate new knowledge by investigating how statistics courses are currently taught to non-specialist students in Saudi universities. Hence, this study will contribute towards closing the knowledge gap that exists in Saudi Arabia.

1.3. Significance of the study

The present study is significant for the following reasons:

1. The study is consistent with the current attention of the Ministry of Education in Saudi Arabia, which is focusing on developing the level and quality of various aspects of education.
2. The study will provide a broad picture of the current situation, regarding how teachers teach statistics courses to non-specialist students and how those students study these courses; neither aspect has been covered by previous research.
3. Statistics courses have become a required course for non-specialist students in many different disciplines. Therefore, there is a need to understand the quality of teaching statistics for those students.
4. The current study offers a useful methodology to evaluate the current quality of teaching and learning statistics; this can be used in other countries around the word, particularly in Arab countries, which suffer from a lack of research in this area.
5. The results of the current study can be seen as an initial step which will serve as an opportunuty to expand this type of research in Saudi Arabia.

1.4. Research questions

The study is guided by the following research questions:

1. How are statistics courses for non-specialist students taught currently in Saudi universities?
2. What are the main challenges that face those teaching statistics to non-specialist students in Saudi universities and how have these been overcome?
3. What are the main challenges that face non-specialist students learning statistics in Saudi universities and how have these been overcome?
4. How could teaching practice in Saudi Arabia be enhanced to reflect appropriate developments in the rest of the world in teaching statistics to non-specialists?

1.5. Overview of methodology

The general design of the current study is descriptive. Mixed methods research is used in this present study; this involves mixing both quantitative and qualitative research methods in one study to address the research problem. There are several reasons for using a mixed methods design in the proposed study: quantitative data allows the researcher to gather data from a large number of participants while qualitative data provides in-depth information from a smaller group of participants (Dawson 2002). Both quantitative and qualitative data complement each other.

The researcher used the first method (questionnaire) to collect data from non-specialist students who had completed at least one statistics course in different colleges at different universities. The second method (interview) was used to collect data from statistics teachers who had taught statistics courses to non-specialist students in these colleges.

1.6. The structure of the thesis

Chapter 1 presents an introduction to the study, comprising the background of the study, research problem, significance of the study, research questions and overview of methodology.

Chapter 2, the literature review, highlights the relevant aspects of learning and teaching statistics to non-specialist students at university level. Furthermore, this chapter examines topics relevant to teaching and learning approaches in higher education. The literature justifies the importance of the current study.

Chapter 3 describes the methods undertaken for the present study, comprising the research design and methodology, research approach, data collection methods, translation of the data collection instruments, the pilot study, sampling design, data analysis and ethical issues.

Chapter 4 presents the results and analysis of the student questionnaires.

Chapter 5 presents the results and analysis of staff interviews.

In Chapter 6 the main findings of the study and their implications are discussed. Some recommendations for practice and for further research are also proposed and conclusions are presented.

Chapter 2. Literature Review

2.1. Introduction

This study aimed to identify the current state of learning and teaching statistics in Saudi Arabian universities. The literature for this research topic was diverse, covering studies from both learning and teaching literature, and from statistics literature that discussed learning and teaching statistics to non-specialist students. This chapter is divided into several sections: (1) Approaches to learning and teaching in higher education, (2) Learning and teaching statistics, (3) Teaching statistics to non-specialist students, (4) The impact of the teacher in learning and teaching statistics, (5) The impact of technology in learning and teaching statistics, (6) The impact of language in learning and teaching statistics and (7) Learning and teaching statistics in different countries.

2.2. Approaches to learning and teaching in higher education

Interest in improving the quality of learning and teaching in higher education has been around for some time, but became more focused in the 1990s. Since that time, remarkable improvements in teaching in universities have been achieved with associated improvements in the outcomes of student learning. The quality of teaching and its enhancement is seen as very important by researchers around the world (Biggs & Tang 2007; Knight, Tait & Yorke 2006).

2.2.1. Student-centred and teacher-centred approaches to teaching

In recent years, several studies have become focused on the approaches of teachers to teaching and their conceptions of teaching. Two important contrasting teaching approaches have been identified: the student-centred and the teacher-centred approaches. The *teacher-centred approach* is described as the teaching pattern that focuses on transferring the knowledge from the expert (teachers) to the novice (students). In this approach, students are considered to be the recipients of information, where the knowledge is constructed by the teacher. Knowledge already assimilated by students is not taken into account. Often in a teacher-centred approach, teachers aim to organize their teaching methods and structure the knowledge they are attempting to convey in ways that make learning easier for students (Biggs et al. 2007; Kember & Kwan 2000; Prosser, Trigwell &

Taylor 1994; Samuelowicz & Bain 1992; Samuelowicz & Bain 2001; Trigwell & Prosser 1996; Vermunt & Verloop 1999).

On the other hand, the *student-centred approach* focuses on the processes of students learning (Kember et al. 2000). Harden & Crosby (2000) defined student-centred learning as *"what students do to achieve this, rather than what the teacher does,"* (p. 335). In this approach students are involved in constructing knowledge and understanding in order to be more independent learners. The main aim is promoting the students' own construction of knowledge rather than transfer of knowledge. Students' individual differences are more meaningfully considered by student-centred teachers during the planning of a course (Biggs et al. 2007; Kember et al. 2000; Trigwell et al. 1996; Vermunt et al. 1999). Lea, Stephenson & Troy (2003) summarise the characteristics of a student-centred approach as follows:

1. *"… the reliance on active rather than passive learning,*
2. *an emphasis on deep learning and understanding,*
3. *increasing responsibility and accountability on the part of the students,*
4. *an increased sense of autonomy in the learner,*
5. *an interdependence between teacher and learner,*
6. *mutual respect within the learner teacher relationship,*
7. *and an approach to the teaching and learning process on the part of both teacher and learner."* (p. 322).

The quality of learning outcomes in higher education is more likely to be associated with the student-centred approach (Trigwell, Prosser, & Waterhouse 1999). Therefore, recommendations from several researchers encourage the move from a teacher-centred approach to the more desirable student-centred approach in order to achieve high quality learning and teaching in higher education institutions (Lindblom & Meyer 1999). Accordingly, there is pressure on teachers in higher education to change their teaching practices and follow a more student-centred approach (Ramsden 2003; Vermunt et al. 1999).

In a study conducted by Kember et al. (2000), 17 lecturers in three universities were interviewed, which identified two broad approaches which they called 'content-centred' (more associated with teacher-centred approaches) and 'learning-centred' (more associated with student-centred approaches). In their research, they identified five strategy dimensions focused on (1) whether instruction was providing the information for students and what they need to learn, or whether it encourages students to use their knowledge and develop it; (2) whether the teacher's focus is directed toward the whole class irrespective of individual differences, or whether it attempts to focus on each student individually; (3) whether the teacher's assessment is based on frequent quizzes and exams, or whether it follows more flexible assessment methods; (4) whether accommodation of students' characteristics is considered by teachers or not; and (5) whether the source of experience/knowledge is provided from the teacher's own experience, or whether it draws upon the experience of students in the class. In order to examine whether teachers are adopting student-centred approaches in teaching statistics to non-specialist students at Saudi universities, interviews with teachers will be valuable in generating in-depth results, which will give a clearer picture of existing practice.

Teaching approaches vary among teachers due to their differing beliefs about the nature of the discipline and how teachers teach the discipline (Richardson 2005). Norton, Richardson, Hartley, Newstead and Mayes (2005) illustrated marked variation in the conceptions of teaching between different disciplinary teachers. However, in their research, teachers at different institutions who taught science disciplines had similar concepts about teaching.

2.2.2. Improving student learning in higher education

Individual students adopt different approaches to learning at different times and in different contexts. Several research studies focused on approaches to students' learning have discussed the differences between surface and deep approaches to learning. In a surface approach, students' motivation emphasizes achieving what is necessary from the course in order to acquire the mark and pass the course. The role of students is passive; they merely reproduce the knowledge. A surface approach has been shown to be associated with lower quality learning outcomes. In a deep approach, students tend to seek meaning and understanding of the subject. Thus, students take an active role in this approach. A deep approach is associated with higher quality learning outcomes (Biggs 1978; Entwistle & Ramsden 1982; Trigwell & Prosser 1991; Van Rossum & Schenk 1984).

Enhancing the quality of students' learning is the main aim of teaching improvement. Learning and teaching are interrelated phenomena where they interact constantly (Kansanen, Tirri, Meri, Krokfors, Husu, & Jyrhämä, 2000). Several studies have been conducted to examine the relationship between teaching and learning more deeply in the school context (Briscoe 1991; Marland & Osborne 1990). At university level, Gow & Kember (1993) and Kember & Gow (1994) identified the correlation between student approaches to learning and teacher conceptions of teaching at department level. The researchers found that in departments with a tendency toward learning facilitation, students followed a deep approach in their learning rather than a surface approach. Furthermore, Trigwell et al. (1999) studied the relationship between approaches to teaching and approaches to learning by an individual teacher and his/her students. The study was conducted with chemistry and physics classes in the first year of study. The researchers found that when teachers focused on transferring the knowledge or what the teacher does, students were more likely to focus on receiving knowledge and follow a surface approach to learning. Furthermore, when the teacher followed a student-centred approach to teaching, students were more likely to focus on understanding their subject and adopt a deep approach to learning. Therefore, the development in teaching patterns adopted by teachers seems to be associated with the learning approaches that students adopt.

The approaches to learning that students adopt are related to the students' learning environment. Where students find teaching to be higher quality – including relevant course content, engaging teaching approaches and assessments not all being clustered together, this is correlated with students adopting a deep learning approach. A learning environment that encourages students to adopt deep approaches can facilitate high quality learning. Improving the learning environment through activities such as giving adequate feedback, clarifying the objectives of the course, making the assessment criteria clear, illustrating the relevance of the course to students, overcoming the difficulties that face students and giving students the opportunity to determine how they want to learn can all help teachers to improve the quality of learning (Ramsden 2003; Trigwell et al. 1991). Regarding statistics education, several studies such as (Christou 2008; Gönül & Solano 2013; Zacharopoulou 2006) illustrated that the improvement of learning environments in teaching statistics helps non-specialist students to achieve their goals from studying statistics courses. However, such developmental studies would be useful for institutions in Arab countries where there has been little research into learning environments.

Changing the direction from teacher-centred to student-centred requires enthusiasm and capabilities from both teachers and students. Some research studies have pointed to reservations in using a student-centred approach to teaching because the teachers believe that students' abilities, enthusiasm and motivations are insufficient to lead them to implement self-reliant activities and be responsible for their learning. Furthermore, some are concerned that a student-centred culture is undesirable to their institutions (van Driel, Verloop, Inge van Werven, & Dekkers 1997). Many students prefer to receive knowledge from the lecturer rather than actively seek out knowledge themselves (Lonka & Ahola 1995).

Some of this preference may be due to students being used to a non-threatening passive form of higher education based on staff lecturing and students taking notes. The quality of learning outcomes from such passive education is questionable, where students do little more than absorb and reproduce knowledge uncritically.

2.2.3. Course design

One of the key factors in supporting learning is the curriculum studied by students. Views about the concept of curriculum have changed from just being a list of topics which provides information to students, to an opportunity to set out strategies and a focus on how to improve students' skills to learn and achieve the objectives of courses (Barr & Tagg 1995; Fink 2007). Within most UK universities the constructive alignment model (Biggs et al. 2007) is commonly used to design courses. This model takes into account how students assimilate new knowledge through constructing new ideas within and around their existing knowledge. The alignment element referred to in this model requires all elements of the course to be coherent with one another. The first step in achieving alignment involves deciding upon the main goals of a course followed by setting intended learning outcomes consistent with these goals. Recognising the important place of assessment in higher education, the next decision in constructive alignment is to select and design assessment methods that enable a student to demonstrate achievement of the learning outcomes. Following this, teaching activities and an evaluation approach are designed to align with the rest of the course components.

When setting course objectives, Fink (2007) suggested six elements that should be considered at this stage in order for students to gain significant learning: 1) foundational knowledge: the set of facts, principles and relationships that create the content of a course; 2) Application: requirements that students should do something with foundational knowledge in most disciplines such as learning physical skills, problem solving, decision making or creative thinking; 3) Integration: identifying for students the similarities or interactions between subjects, theories and historical trends; 4) Human dimension: where students learn something about themselves or how they interact with others; 5) Caring: when feeling, interests or values of students are changed in relation to the subject; 6) Learning how to learn: teaching students everything they need to know is impossible, so we need to help them learn how to keep learning when the course is finished. Fink (2007) argued that *"The premise is that any course can address all six of these general kinds of learning. And the more of all six the course can promote, the more significant will be the overall learning experience for the student,"* (p. 14).

2.3. Learning and teaching statistics

2.3.1. What is statistics?

The use of statistics is wide-ranging and includes most aspects of our life. Usually when we read news articles, use the internet or watch programmes, we face many different types of information and data presented as graphs or charts and some terminology such as *average*, *trends* and *correlation*, which are all within the scope of statistics. Therefore, it is valuable for people to know the concepts these terms refer to in order to understand the information they represent. Furthermore, the correct understanding of information assists decision makers to make accurate or informed decisions.

Historically, the first impression of statistics was the gathering of information about the idea of 'the state of things' (WikiBook). The first appearance of the term statistics was in a paper written by Gottfried Achenwall in the middle of the eighteenth century (Haack 1979; Zidek 1986), although statistical methods were being used much earlier than this.

When non-specialists are asked about what statistics is, a variety of answers are normally given, the majority of which indicate that the meaning of statistics relates to numbers, figures, diagrams or information. Often, students link statistics with calculation and counting (Blejec 1993). Moreover, a study conducted by Phillips (1990) on people entering higher education in Australia, which measured students' attitudes towards statistics, indicated that students view statistics as numbers, calculations and data that will be meaningfully presented in tables. Such studies help teachers to better understand students' views of statistics prior to them commencing study.

Several textbooks in introductory statistics define statistics as a discipline that includes all aspects of gathering, presenting, processing and interpreting (Clarke & Cooke 2011; Freund & Perles 2004; Moore 2001). Hoaglin and Moore (1992) define statistics as *"the science of gaining information from data. Data [are] of course numbers, but they are more than that. Data are numbers with a context,"* (p. 1). Furthermore, Aliaga and Gunderson (1998) describe statistics as a circular process between four stages which are: formulate theories, collect data, summarise results and interpret results. In addition, the study of probability is sometimes included within the scope of statistics, for example, the Collins English Dictionary (Butterfield 2003) provides two definitions for statistics, and one of them is *"the classification and interpretation of such data in accordance with probability theory and the application of methods such as hypothesis testing to them."*

Biehler (1993) indicates that the answers to the question 'what is statistics?' have been highly variable in history. Yet, this variability influences the design of curricula, research and teacher education. For instance Gnanadesikan and Kettenring (1998) describe statistics as a 'data science' with associative relation to mathematics and computer science. Commenting on this view, Biehler (1993) points out that *"This is in fact a very modern definition which brings the changed nature of statistics to the point; putting 'data' at the centre of statistics and mentioning computing science on an equal standing with mathematics as a closely related discipline,"* (p. 20). As statistics is such a debatable concept, it is not surprising that statistical definitions and meanings will change in the future, alongside developments that are happening in other disciplines such as computer technology, economy and social development (Bibby 1986).

2.3.2. The difference between statistics and mathematics

After increasing numbers of studies in the field of statistics and its emergence as a specific discipline, statisticians have struggled to illustrate the difference between statistics and mathematics. Moore (1998) argued for the independence of statistics since it is characterised by particular techniques of thinking: *"Statistics is a general intellectual method that applies wherever data, variation, and chance appear. It is a fundamental method because data, variation, and chance are omnipresent in modern life. It is an independent discipline with its own core ideas rather than, for example, a branch of mathematics."* (p. 1254). One feature of statistics is that numbers and data have a certain connotation where the context provides the meaning of the data, and the data cannot be meaningful or interesting until their context is known (Moore 1992 in Garfield et al. 2008; Cobb & Moore 1997). Furthermore, Rossman, Chance, and Medina (2006) in Garfield et al. (2008) pointed to one more difference between statistics and mathematics, which is that mathematical procedures and concepts are used in statistics as tools to solve statistical problems; the researchers described statistics as a mathematical science, but as an independent discipline.

This difference requires university lecturers to carefully consider the teaching methods used to teach statistics, where it is often the same teachers teaching both mathematics and statistics courses. In teaching mathematics, teachers seek to reach the mathematical solution. However, this situation is different in teaching statistics, where the concepts of the data and what interpretations can be drawn from the results should be the primary focus. Furthermore, preparation for teaching statistics requires the statistics teacher to have experience in skills such as data analysis and the ability to use statistical software

(Garfield et al. 2008). That may illustrate the differences between statistical thinking, which focuses on the idea behind the results, and mathematical thinking, which is limited to mathematical solutions (Garfield et al. 2008). DelMas (2004) encourages the use of the statistical thinking approach in statistics classrooms where it can lead students to gain a deeper understanding. However, delMas (2002) pointed out that the discussion about data collection procedures, how and why the appropriate method of analysis is chosen, how the conclusions are drawn and how to interpret them should be included in the experiences of students. Accordingly, focusing on understanding the statistical concepts rather than the computation in teaching statistics is compatible with a student-centred approach to teaching and students adopting a deep approach to learning.

2.3.3. Statistics education

Statistics education is a relatively new field that, to some extent, has been affected by other disciplines such as mathematics education and psychology education (Garfield 1995). Over the past twenty years there has been considerable interest in the field of learning and teaching statistics where the number of researchers in statistics education is increasing (Becker 1996; Garfield et al. 2007; Garfield et al. 2008; Moore 1997; Tishkovskaya et al. 2012). Furthermore, research into learning and teaching statistics has affected both statisticians and non-statisticians through its impact on changes to the content and structure of courses.

Previously, it was not easy for those who wished to read further about statistics education, since it was not an independent discipline and so many studies were published in the journals of a variety of different disciplines (such as mathematics education, educational technology, psychology or science education) that focused on educational statistics (Garfield et al. 2007). However, this situation has changed as statistics education became a more independent discipline with its own scientific journals and conferences, such as the Journal of Statistics Education, Statistics Education Research Journal, Journal of Teaching Statistics and the International Conference on Teaching Statistics (ICOTS). In addition, a growing number of graduate students have completed their doctoral research in learning and teaching statistics (Garfield et al. 2007; Zieffler, Garfield, Alt, Dupuis, Holleque, & Chang 2008). However, Zieffler et al (2008) indicated that graduate programmes designed to prepare research in statistics education are still limited.

On the other hand, some studies have emerged that focus on clarifying the characteristics of statistics. These discussions were carried out by statisticians and statistics educators and divided into three main areas: statistical literacy, reasoning and thinking (Garfield et al. 2007). These three constructs form important goals in statistics learning. delMas (2002) argues that where students do not understand these concepts it can lead to an inability to link what teachers teach, what students learn and what teachers assess.

Statistical literacy. Statistical literacy is a term used to suggest an understanding of basic statistics that enables people to understand the results of calculations carried out on everyday information, such as information found on the internet and in newspapers. Key to statistical literacy is identifying what basic statistics are required (Gal 2003). Statistical literacy includes knowing the meaning of the basic statistical terms and symbols, understanding concepts, the basic language of statistics, being able to use tools of statistics and interpreting various data representations (Rumsey 2002; Snell 1999). Another view of statistical literacy suggested by Gal (2002) is *"people's ability to interpret and critically evaluate statistical information, data-related arguments, or stochastic phenomena, which they may encounter in diverse contexts,"* (p. 2). These definitions illustrate the importance of the ability to understand, critically evaluate, and interpret the statistical information that people may encounter in any place.

Statistical reasoning. Ben-Zvi & Garfield (2004) defined statistical reasoning as *"the way people reason with statistical ideas and make sense of statistical information,"* (p. 7). Statistical reasoning involves the ability to: link statistical concepts with each other (such as mean, association and spread), understand the importance of these concepts, explain the processes of statistics and interpret the results where that helps in making statistical inferences and interpreting the results (Garfield 2002; Garfield et al. 2007).

Statistical thinking refers to advanced statistical patterns of thinking used by statisticians and is considered a higher level of processing than implied by statistical reasoning (Wild & Pfannkuch 1999). Statistical thinking includes: the ability to gather the data necessary for research and the ability to summarise these data to show their characteristics by determining the optimal measurement (Pfannkuch & Wild 2004). Furthermore, choosing the most appropriate statistical techniques to analyse the data, how to use it and why, and understanding the theories of statistical processes are considered key aspects covered by statistical thinking (Garfield et al. 2007). Understanding the problem of the study, being able to plan the investigation and how to draw out the conclusions are also key steps in statistical thinking (Chance 2002). Garfield et al. (2007) argue that *"Statistical literacy, reasoning and thinking are unique areas but there is some overlap and a type of hierarchy, with statistical literacy providing the foundation for reasoning and thinking,"* (p.

381). Regarding the learning and teaching approach in higher education as discussed above, it is valuable to point out that many aspects of statistical reasoning and thinking correspond with the main goals of the student-centred approach.

Identifying what non-specialist students should learn from statistics courses is a crucial point in learning and teaching statistics. When teaching some courses there are interactions between key factors, including goals of teachers, students conceptions and abilities, how students learn and how students should be taught. Most studies of learning emphasise the importance for students to be active in their own learning as a factor in the educational process, through helping them to construct knowledge and develop their concepts and skills instead of students copying the information delivered to them. These theories of learning interact with the goals of teachers and the objectives of the courses, where the questions that students are asked on exams, do not necessarily enable students to demonstrate the extent to which they achieve these goals. For instance in statistics, students' ability to calculate standard deviation by hand is not supposed to be the teachers' goal, but understanding statistical concepts and students becoming statistical thinkers should be what teachers are looking for (Garfield 1995).

After reviewing the history of scholars' thinking about teaching statistics and its appearance as an independent discipline, the importance of statistics and how it relates to other disciplines becomes clearer. However, as previously explained, the importance of statistics is not limited to statisticians but includes non-specialists as well. Therefore, this study will focus on particular aspects related to learning and teaching statistics to non-specialist students in higher education.

2.4. Teaching statistics to non-specialist students

2.4.1. Statistics in the curriculum of universities

The interest in statistics is limited not only to statisticians but also includes non-statisticians in various disciplines, who use statistics within their fields. Statistics can offer learners in other disciplines the ability to understand and to think statistically about the quantitative information that is around them (Garfield et al. 2008). At university level, statistics is considered as one of the most important subjects in the curriculum, where several academic departments realise its importance shown by a continuing increase in the number of students from a variety of disciplines enrolled in statistics courses (Garfield et al. 2008;

Scheaffer et al. 2004; Watson 1997). Student ability to understand the basic concepts of statistics (see earlier discussion of statistical literacy) and their mastery of certain skills, such as collecting data, selecting the appropriate statistical technique and interpretation of results are the main aim of introductory statistics courses (Pieraccini 1990; Schuyten 1990). Thus teaching basic statistics to non-specialist students in higher education is a crucial area requiring attention (Garfield et al. 2008; Simpson 1995).

Several research studies have focused on the area of introductory statistics courses for non-specialists and have focused debates upon whether statistical reasoning or statistical methods should be included or not. Currently most researchers appear to encourage inclusion of statistical reasoning (concepts and thinking) in addition to statistical methods (computations) (Bradstreet 1996). Furthermore, Bradstreet (1996) pointed out that statistical reasoning is providing students with some statistical practices and skills needed in their specialities, such as the ability to choose the right question for their study and how to design it, how to collect data needed, how to select an appropriate statistical method for analysis and then how to interpret the results. Non-specialist students may not require the understanding to carry out a complex statistical operation, but they do need to understand these key concepts and how to use them in decision-making (Bradstreet 1996).

It is essential that an introductory statistics course contains several important aspects, including data collection and graphical display of data but less attention should be paid to mathematical elements (Snee 1990). Cobb (1993) suggested that beginning statistics courses at university level should involve statistical thinking to understand the concepts and real data should be used, but with less theory. Furthermore, Cobb (1993) lists some suggestions about the course:

1. “Introductory statistics need not be taught as a survey course
2. A first course need not be organized by statistical topic
3. A first course need not present topics in the standard order
4. A course need not rely on lectures to present the material.”

Based on the diversity of the disciplines of students, teachers should pay attention to what should be contained within statistics courses and what their objectives are. For example, Simpson (1995) mentioned that *"the majority of medical students go into clinical practice, which involves clinical decision making. We decided therefore to reduce the time devoted to the statistical methods of medical research, and add about 40 per cent new material with emphasis on clinical decision making,"* (p. 202). It is not surprising that the importance of statistics in business and management is recognised, as students in this discipline need to analyse real data. In response, the target of business statistics courses has moved from emphasising theory to practice (Love & Hildebrand 2002). Therefore, deciding what teachers of statistics should teach to non-specialist students is the most important step to be able to connect statistics courses with the real world challenges in these students' individual disciplines.

2.4.2. Non-specialist students' views of statistics

It is not surprising for teachers who teach statistics to non-specialist students to face students who experience statistical anxiety as Garfield et al. (2008) suggest: *"Despite the increase in statistics instruction at all educational levels, historically the discipline and methods of statistics have been viewed by many students as a difficult topic that is unpleasant to learn,"* (p. 4).

Unfortunately where students hold a negative view of mathematics, there is a misconception rooted among many students that statistics is a branch of mathematics. Many non-specialist students studied some mathematics courses in high school. When their mathematics preparation is insufficient, they often refer to the inability to complete the course in statistics where mathematics skills are considered key to success (Bradstreet 1996). Therefore, the feeling of students toward mathematics and statistics is often the same and students think they will focus on numbers, computations and one correct answer in statistics courses. However, this is not the case because in statistics they are more likely to focus on collecting data, analysing these data and the different possible interpretations of data (Garfield et al. 2008). This negative feeling from some non-specialist students towards statistics courses and the misconception of linking statistics with mathematics is reinforced by some of the teaching methods which are used by statistics teachers also suggest to students that statistics is treated as a branch of mathematics (Simpson 1995).

On the other hand, the non-cognitive factors such as student feelings, attitudes and beliefs may influence the learning and teaching approaches used in statistics courses for non-specialist students. Gal & Garfield (1997) pointed out that measuring student beliefs and attitudes toward statistics ought to be carried out before, during and after studying the course of statistics. They refer to three reasons for this: their impact on 1) the teaching and learning process; 2) student behaviour in statistics after they leave the classroom; 3) students' desire to undertake further study in statistics. Several studies have examined the role of beliefs and feelings towards statistics and to what extent these factors influenced the study of statistics courses. For instance, the study carried out by Budé, Van De Wiel, Imbos, Candel, Broers & Berger (2007) indicated that the scores on achievement were adversely affected by the negative attitude of the students toward statistics. Identifying student anxiety toward statistics courses at the beginning of the course may help teachers to overcome some of the difficulties that may face students (Bradstreet 1996). As a result, instructors should take into account the perspective of students towards statistics, illustrate the importance of statistics for students and encourage students to practice statistics to achieve the full benefit of the course (Zieffler, et al. 2008). However, many teachers would find it difficult logistically, to carry out studies of students' attitudes prior to, during and after all their statistics courses. These studies are important in measuring the impact of non-cognitive factors to build a clearer picture about the situation of teaching and learning statistics, but the current research study focusses instead on investigating how statistics courses are currently taught.

The qualitative study carried out by Petocz and Reid (2002), based on interviews with undergraduate statistics students studying for a mathematics degree, concluded that there is a relationship between students' conceptions of learning and their conceptions of teaching. Students' responses to questions about learning statistics were categorised into six groups by Petocz & Reid (2002; p.2-3):

1. "Doing: learning in statistics is doing required activities in order to pass or do well in assessments or exams.
2. Collecting: learning in statistics is collecting methods and information for later use.
3. Applying: learning in statistics is about applying statistical methods in order to understand Statistics.
4. Linking: learning in statistics is linking statistical theory and practice in order to understand Statistics.
5. Expanding: learning in statistics is using statistical concepts in order to understand areas beyond Statistics.
6. Changing: learning in statistics is about using statistical concepts in order to change your views."

Furthermore, Petocz & Reid (2002; p.3-5) categorised the student responses about their conceptions of teaching statistics into five groups;

1. "Providing materials, motivation, structure.
2. Explaining material and helping with student work.
3. Linking statistical concepts and guiding learning.

4. Anticipating student learning needs.
5. Being a catalyst for 'open mindedness'."

In general, previous groups illustrate that the three important areas of overlap between learning and teaching from the point of view of participants cited by Petocz and Reid (2002; p.5) 1) a focus on techniques; 2) a focus on the subject; 3) a focus on the student. One of the most important results of the study mentioned by Petocz and Reid (2002) *"Almost all students in our sample indicated that an important component of teaching was enthusiasm, interest and motivation,"* (p. 5).

A study conducted by Harraway & Barker (2005) included 913 research graduates from economics, finance, marketing, the biological sciences, psychology, nutrition and food science with Masters and PhD degrees from the seven New Zealand universities. The study indicated the existence of gaps between statistical techniques used in the workplace and techniques learned at universities, and indicated the obvious insufficiency in the way students were prepared for employment. The respondents pointed to the need for some important topics to be taught such as multivariate methods, regression and generalised linear models, and survey design and power analysis. Several recommendations are presented in the study including the need to provide workshops that help students meet their statistics needs with regard to their disciplines, workplace retraining and expansion in advanced statistical service courses. However, the study was limited to postgraduate non-specialist students only and did not include undergraduate students. Moreover, the study period was from 1995 to 2000, where it missed some current developments – for instance, the use of modern statistical software packages.

Several studies focused on statistics education offer numerous instructions to identify the appropriate methods in teaching statistics. One of the most prominent of these studies is the Guidelines for Assessment and Instruction in Statistics Education: College Report (GAISE), a project funded by the American Statistical Association. The GAISE college report provides six recommendations for teaching statistics cited by Aliaga, Cobb, Cuff, Garfield, Gould, Lock, Moore, Rossman, Stephenson and Utts (2005; p.4):

1. "Emphasize statistical literacy and develop statistical thinking.
2. Use real data.
3. Stress conceptual understanding, rather than mere knowledge of procedures.
4. Foster active learning in the classroom.

5. Use technology for developing conceptual understanding and analysing data.

6. Use assessments to improve and evaluate student learning."

In this thesis, we see overlaps between points 3, 4 and 5 since the use of technology for data analysis and for developing students' conceptual understanding could contribute to the classroom becoming more interactive as well.

The aspects and aims of the student-centred approach, which are discussed in the previous section are compatible with these recommendations, particularly point 4, for teaching statistics.

2.4.3. Collaborative learning in statistics

Collaborative learning includes various definitions, but is the attempt of two people or more to learn a specific thing through working together (Dillenbourg 1999). In a study in the 1970s, Shaughnessy (1977) argued that the misconceptions of students about probabilities are overcome by small group working in class. In another study, Dietz (1993) revealed that the use of collaborative learning activities in statistics courses helped students to discover the technique best-suited to them in the selection of a sample, which provided them with a better understanding of these methods. In a third study (see Jones 1991, in Garfield 1993) a researcher noted several positive actions when using collaborative learning in statistics courses, such as, increases in attendance, students' participation in the classroom, students visiting teachers in their offices and improved students' attitudes.

After that, several studies have been conducted to measure the impact of the use of collaborative learning in teaching statistics for undergraduate students. One study conducted by Potthast (1999) illustrated the impact of using collaborative learning in one section of a statistics course compared with individual learning and lectures in another section of the same course, by comparing the difference between the test scores of students. The study indicated that students' results in collaborative learning sections are better than the results of students in the more individual sections of the course. Furthermore, three other studies (Keeler & Steinhorst 1995; Magel 1998; Perkins & Saris 2001) showed the influence of collaborative learning by comparing test scores between courses applying this approach and a previous course which did not include it. All these studies found that students' test scores in collaborative learning courses were higher than scores of students on traditional courses. However, previous studies used the test scores of students as a standard for comparison between results, but it should be noted that the scores might not represent the statistical understanding of students.

Magel (1998) and Keeler et al. (1995) reported that collaborative learning had made classes more interactive and students desire to study the course increased. The association and compatibility between the outcomes of previous studies in collaborative learning in statistics and the characteristics of the student-centred approach are clear, as mentioned above (see section 2.2).

2.4.4. Challenges of teaching statistics to non-specialist students

Many researchers have been trying to identify the challenges that occur in learning and teaching statistics and to find ways to overcome these difficulties. As mentioned earlier, one of the most important goals for non-specialist students in studying statistics is learning the ability to use it in their main subject of study and in real life. This ability to use statistics requires three main competencies, which are mentioned by Yilmaz (1996): *"Ability to link statistics and real-world situations, knowledge of basic statistical concepts, and ability to synthesize the components of a statistical study and to communicate the results in a clear manner,"* (p. 2). As these points are essential, the difference between specialist and non-specialist students are not in the selection of these competencies, but in the disparities of the development of these competencies (Yilmaz 1996).

Undoubtedly, most of the restrictions that hamper the development of these competencies, especially for non-statistics students, are the relatively low number of statistical courses which are taught to them in a limited time. These challenges are the following; some fundamental statistical concepts (such as randomness, distributions of sample statistics and probabilities) may be complex and not easy for non-statistics students to understand in the restricted time allocated to these courses. Secondly, data analysis is an essential skill in statistics and again, the time restrictions for teaching non-specialist courses makes it hard to teach students data analysis or provide the opportunity to participate in practical tasks. Finally, learning statistical problem-solving often requires some mathematical background, which is often lacking in non-specialist students (Harraway 2010; Yilmaz 1996).

2.4.5. Assessments in statistics

Several researchers have argued that the common assessment approach that relies heavily on exams and grades is no longer the most effective method to assess students' understanding or success in learning (Garfield & Gal 1999). Views of assessment in higher education are changing from the traditional perception that many people think of, related to 'testing' and 'grading', and now include considering ways of measuring students' understanding of statistical concepts, judging students' ability to achieve the objectives of the course and assessing their ability to apply what they have learned (Darling-Hammond, Ancess, & Falk 1995; Garfield & Chance 2000). Recent work has also highlighted the role of assessment not simply as a test of what a student knows (assessment *of* learning), but also the importance of well-designed assessment methods as a potential opportunity for further learning (assessment *for* learning) (Sambell, McDowell & Montgomery 2012).

There are several benefits to be obtained when using alternative methods of assessment. For instance, obtaining adequate information about the level of learning among students and the abilities of students to deal with this knowledge. The use of several methods of assessment can provide valuable information about the level of student learning (Garfield et al. 1999) as well as providing opportunities for students to learn different elements and approaches to the subject.

Garfield et al. (2000) provided several alternative assessment methods that help students to learn statistics effectively (p.103-104):

1. Individual or group projects: these projects contain the four major components in learning statistics which are posing a question, collecting appropriate data, analysing the data and interpreting the results.
2. Case studies: "similar to projects, case studies allow students to study and reflect on actual examples from statistical practice," (p.103).
3. A portfolio of student work: collecting the work done by the students such as a mini research paper, output for data analysis, group project and midterm exams during entire period of the course by both students and teachers.
4. Concept maps: "include the concepts... and the connections... that relate them," (p. 103).
5. Critiques of statistical ideas or issues in the news: teachers may ask their students to read articles in a magazine or newspaper then critique them statistically.

With the diversity of possible assessment approaches that can be used the challenge is how to choose the best method for assessment and learning. Following Biggs et al.'s (2007) constructive alignment model, the teacher needs to identify the objectives of the statistics course for non-specialist students and ensure that any new assessment methods align with the specific course goals.

2.4.6. Use of real data

One of the most important points about statistics courses is that they need to be relevant to practical use in different disciplines and in future careers. Unfortunately, some non-specialist students believe that statistics courses are not relevant to their disciplines. Simpson (1995) explains that this is "*an impression often reinforced by the lack of importance given to it in their examinations or other assessment, or by the other lecturers in their own discipline,"* (p. 200). To overcome this issue Bradstreet (1996), Everson et al. (2008) and Simpson (1995) have suggested that the examples and data which are used in lectures, tutorials and assignments have to be real and relevant to the subjects of non-specialist students. Relevant data and examples increase students' awareness of the importance of statistics to their main subject and real life (Snee 1993). Another benefit is cited by Bradstreet (1996) *"The students will remember the statistical methods as those that were used to solve a real world problem instead of members of a list of isolated formulas that they memorized for, and forgot shortly after, a test,"* (p. 71).

Making real data sets available is considered a useful way for both students and teachers to deal with the relevant data during studies. One of the benefits of the availability of data in scientific journals is not only that students can use these data to learn how to deal with data, but that it can also encourage and motivate students to read from scientific journals (Simpson 1995).

2.5. The impact of the teacher in learning and teaching Statistics

2.5.1. Conceptual understanding in teaching statistics

A crucial point that arises in statistics education is the difference in methods of teaching statistics and teaching mathematics. Greer (2000) mentions that these differences suggest the need to take into account the development of statistics teachers. Furthermore, Greer (2001) suggests that with the changing of interest and aims in statistics education from statistical skills development (literacy) to focus on the development of statistical thinking and reasoning, instructors are required to select the appropriate methods in teaching statistics and develop their approaches to promote the conceptual understanding of statistics among their students. In order to facilitate this higher order statistical thinking and reasoning, teachers are required to have a very good understanding of statistics themselves, and this clearly has implications for ensuring teachers are well prepared for statistics teaching.

2.5.2. Teachers' statistics knowledge

A knowledgeable teacher is key in helping students to overcome common misconceptions in areas such as, averages, variation, graphical representation and probability. Furthermore, some frameworks for student understanding about particular statistical topics have been developed such as Jones, Thornton, Langrall, Mooney, Perry and Putt (2000), thus some researchers have pointed out that the impact of teachers teaching statistical concepts should be considered when exploring students experiences of learning statistics.

Determining teachers' knowledge in statistics is important in teaching statistics. However, many studies exploring teachers' knowledge of statistics have been conducted with teachers at school level; university level statistics courses have similar issues, but there appears to have been no research in this area. Not infrequently, statistics courses for non-specialist students at university level have been taught by non-statistics teachers. This means there is a need for future research to focus on this area to investigate teachers' knowledge and its impact on teaching those students.

Lack of availability of suitably qualified teachers is one of the main problems in teaching statistics. For instance in the UK, Greer (2000) mentions that there was no training of qualified teachers to teach statistics until the present time, which has led to a scarcity in the availability of statistics teachers. To date, there is no reference to identify the availability of suitable teachers of statistics in Saudi Arabia.

2.5.3. Teachers' attitudes toward statistics

Martin, Prosser, Trigwell, Ramsden, & Benjamin (2000) indicated that the quality of learning and teaching depends largely on what *"teachers want their students to learn,"* (p. 411). Relationships were found between beliefs about learning held by teachers at university level and their practices of teaching (Samuelowicz & Bain 2001). One of the most important indicators of the eligibility of a teacher to teach statistics is his or her attitude towards statistics. Some mathematics teachers seek to avoid teaching statistics courses due to a lack of confidence in teaching statistics. If these teachers have been asked to teach some topics in a statistics subject, they may provide statistics topics as just additional topics in the mathematics syllabus and might teach them without enjoyment or enthusiasm (something students consider a key part of good teaching). Hawkins (1993) pointed out that these teachers would not succeed in motivating students to learn about the key characteristics of statistics and recognise the potentially wide applicability of statistics.

In the UK, Hawkins (1993) conducted a study that included 349 school teachers who taught statistics. The vast majority of teachers who were specialists in Mathematics and Statistics claimed to enjoy teaching both statistics and probability. However, although the teachers from other disciplines generally enjoyed teaching statistics, far fewer of them enjoyed teaching probability, especially at secondary level. Furthermore, the study discovered that most of those teachers found probability to be 'not applicable' to them. Therefore, Hawkins stressed the necessity for teachers to change their attitudes toward statistics education in order to achieve successful learning outcomes in schools. Furthermore, the study conducted by Gattuso and Pannone (2002) found that most mathematics teachers in Italy look favourably toward statistics, however they do not support the allocation of extra time for statistics at the expense of mathematics topics. These studies are informative, but it is also important to conduct these kinds of studies at university level.

2.5.4. Statistics teaching methods

A gap still exists between the research on effective teaching and current teaching practices in statistics where some teachers are not aware of the diversity of teaching methods used by other disciplines (Tishkovskaya & Lancaster 2012). Added to this, various studies have noted that statistics is not easy to learn and teach, while many of the results of these studies indicated that students did not learn what was taught to them, or the students were not able to apply what they have learned (Garfield & Ahlgren 1988). Garfield et al. (2008) argue that *"... traditional approaches to teaching statistics focus on skills, procedures and computation which do not lead to reason or think statistically,"* (p. 7).

At university level, the aims of most of the non-specialist students who attend the introductory statistics courses are memorising the formulas in statistics and learning how to deal with them in order to succeed in the course (Ramsey 1999). Harkness et al. (2003) listed several reasons that are causing the weakness of the traditional format of teaching introductory statistics course (p. 9):

1. The traditional format did not address the broad range of differences in student learning styles and quantitative skills
2. The original format did not encourage active participation
3. Students were unable to apply statistics in follow-up courses
4. They had a negative attitudes towards statistics
5. Retention of subject matter appeared to be very short
6. The course did not provide sufficient tutoring assistance for students

Related to this, the preparation and training of people who teach is a point of concern for many mathematics and statistics departments in various universities in the world (Moore 2005). Moore (2005) mentions that *"Changing our understanding of what constitutes effective pedagogy, improving the use of technology, and placing an emphasis on working with data in elementary courses raise the standard that teaching assistants must meet. Many graduate students come from countries with cultures and education systems quite different from those in the United States. Training programs should themselves be models of good pedagogy,"* (p. 1). While many universities in the UK and other Western countries have formal programmes for new academic staff focused on enhancing teaching approaches, currently, there are only a few courses that focus on the preparation of statistics teachers at any level of education (Garfield et al. 2008). These courses are usually offered at undergraduate statistics level and the course aims to prepare the students to be good teachers in the future through focusing on the teaching methods in statistics (Garfield & Everson 2009).

2.6. The impact of technology in learning and teaching Statistics

2.6.1. The role of technology in education

Nowadays technology has become one of the important things in most aspects of life, especially in education. Technology has made communication between individuals easier (for example, social networking software) compared to the past, although new programs require understanding of how to use these techniques (Leece & Campbell 2011). The modern technology programs provide the opportunity to interconnect the educational process in order to increase the motivation of learners to learn (Leece et al. 2011). Enabling students to take advantage of technology in education is essential as the technology has become one of the necessities of life (Tamim, Bernard, Borokhovski, Abrami & Schmid 2011).

According to Cadiero-Kaplan (1999); technology has had a very important impact on education as most universities use technology tools, such as the Internet and virtual learning environments as well as statistical software programs in classes. Ringstaff et al. (2002) pointed out that the use of computers improved the achievement and performance of students in class to a level better than students in traditional classes. Moreover, the use of technology can save time, which can encourage interaction between students and allows them to continue their learning outside the classroom (Li 2003). However, this use does not negate the role of instructors as Li (2003) cited that *"remaining vigilant in learning* *technological processes and the technological materials provided a source to enhance the teaching/learning process and not to replace the teacher,"* (p.72-73).

2.6.2. Technology in statistics courses

The evolution of technology has affected student learning outcomes in statistics and the techniques used by teachers in teaching statistics (Chance et al. 2007; Moore, Cobb, Garfield, & Meeker 1995). Tishkovskaya et al. (2012) pointed out that prior to the development in technology, students' focus was on how to solve statistical problems through manual calculation or to derive particular formulas. However, this situation has changed where the aims of statistics courses focuses on understanding the concepts of statistics rather than the computational mechanics.

Fey (1989) stresses that with the emergence of modern tools of technology that can be used in statistics, and with the continuity of their development, it is necessary to review every couple of years the statistics curricula and teaching methods that are used in order to take advantage of technology. Currently, technology has become the key component in statistics as Chance et al. (2007) mentioned *"It is hard to imagine teaching statistics today without using some form of technology,"* (p.1). Chance et al. (2007) indicated the need to recognise the direct impact of technology on the contents of statistics courses and pay attention to how to use the technology tools properly to get the best results. These require teachers to review and re-examine the goals of the curricula especially for statistics courses. This review is important to ensure that the content of the curriculum is adapted with modern technology, this will help teachers and students to ensure that they can achieve goals with the use of technology (Cauley, Aiken, & Whitney 2009).

By increasing computer availability at this time, it has become necessary to include computers in statistics courses to illustrate the statistical concepts as Cabilio and Farrell (2001) pointed out. They used a computer lab to teach an introductory statistics course where two lab experiments are presented. Furthermore, the worth of multimedia technology in teaching and learning statistics and the role of the teacher are demonstrated by Velleman and Moore (1996). They pointed out that multimedia was appropriate with the pedagogy and content of the course and particular techniques have to be used to teach students data analysis. Statistics software, simulation and exercises with feedback are some of the multimedia materials/tools that may be used in class.

Nicholl (2001) indicated that evolution in technology has resulted in a change in statistics courses where they used to be dominated by the theoretical aspects of statistics before technology, but now theories can be integrated with real examples. On the other hand, Nicholl (2001) highlighted the needs of the employment market for statisticians, stating that *"Future directions in the teaching and learning of statistics must take into account the impact of Information Technology with the competing need to produce scholars as well as competent users of statistics to meet future needs of the market,"* (p.11).

Watson (1998) referred to the importance of teachers' statistics efficiency in the use of multimedia technology in teaching. When multimedia technology emerged as a factor that can motivate students to learn, it became imperative for teachers to develop their skills in the technology use and determine the appropriate educational approach in their classrooms. Currently available technologies that can be used in teaching statistics and learning statistics have been divided by Aliaga et al. (2005) into several types: graphing calculators, statistical packages, educational software, applets, spreadsheets, web-based resources including: data sources, online texts, and data analysis routines and classroom response systems.

2.6.3. The impact of technology on students' statistical learning

Contrary to the case twenty years ago, where the statistical calculations and problems were worked out by hand and calculator, the processes and statistical calculations are different now due to technological advances, and thus techniques and methods of teaching statistics have changed (Chance et al. 2007). Unfortunately, the impact of technology on learning statistics is still late in developing countries compared with developed countries, and there is a large variation in the use of technology in different countries (Hamadu, Adeleke & Ehie 2011).

Where technology has helped teachers to teach statistics, it also tends to help students to learn statistics and how to apply it. The use of technology leads students to several things; collect data on a large-scale and deal with them more accurately, they can do the statistical procedures and operations automatically, obtain the results, carry out their statistical interpretations and display them with more clarity. These facilities help to enhance the confidence among students and improve their ability to use statistics (Chance et al. 2007). Despite the significant benefits offered by technology which help learners improve their understanding of statistical concepts, it is necessary for statistics teachers to evaluate these programs from the perspective of students to determine any appropriate tools for learning and practising statistics in introductory statistics courses (Biehler 1997).

One study conducted by Garfield, Hogg, Schau, and Whittinghill (2002) explored the current situation of a first level statistics course by using a teacher survey. Major positive changes with the use of technology were found in their study: *"there was also a common theme among many instructors who stated that they focus more on concepts and big ideas and on data analysis and interpretation and less on computation, formulas, and theory."* Regarding the understanding of statistical concepts and the course aims, the researchers *"believe that appropriate content, a focus on data analysis and real problems, and careful use of high quality technological tools will help students better achieve the suggested course goals and outcomes. However no one has yet demonstrated that a particular set of teaching techniques or materials will lead to the desired outcomes."*

The advantages of Computer Assisted Instruction (CAI) in introductory statistics courses are demonstrated by Basturk's (2005) study. Learning outcomes of two groups of participants were compared. The first group integrated CAI into a lecture on introductory statistics course with 65 participants, while the second group had 140 participants and was based on a lecture only. The researchers found that the first group of participants obtained higher scores in their midterm and final exams than the second group, where the performance on concepts and practices was the obvious reason for this difference. Moreover, the learning gap between them increased when the topics moved from descriptive statistics to inferential statistics. The researcher concluded that the use of CAI in introductory statistics courses could improve students' learning and their understanding successfully.

With the widespread use of computers in educational environments and the availability of the internet in many places, this has helped people to find courses taught online, and this is considered to have been a catalyst in the growth of learning statistics and wider sharing of easier methods of teaching statistics. Moreover, technology has provided us with modern methods that assist in establishing collaborative discussions among students and interaction between students and instructors (Chance et al. 2007; Everson et al. 2008). It is clear that technology has a great ability to develop and enhance teaching; however, this change does not happen unless technology is used and supported properly. In online courses, instructors may not be able to hear the discussions among students directly which can prevent the teachers from identifying misunderstandings or misconceptions of students about the course (Everson et al. 2008).

2.6.4. Appropriate technology tools

It is a crucial point that researchers and teachers should focus on identifying the appropriate technology for use in teaching and learning statistics in different disciplines. Some researchers suggested several points that should be taken into account during the use of technology including, identifying the ability of students to use any kind of technology, as for example, statistical software programs have different levels of complexity. Also teachers should identify the suitability of any technology for helping to teach and learn the content of the statistics course (Hawkins 1997). Therefore, teachers should be looking for how they can choose appropriate tools for their students (Chance et al. 2007).

There are a lot of technology tools that can be used in teaching statistics, so it is important to know that these tools work to achieve different goals. Therefore, teachers may need to use several tools to achieve different goals. Moreover, it is necessary for teachers to remember that the main goal in the use technology tools is to teach the statistical curriculum content and concepts for students in the classroom and not to spend too much time teaching the details of how to use these technologies. Also as Chance et al. (2007) mentioned that *"Teachers are encouraged to view the use of technology not just as a way to compute numbers but as a way to explore concepts and ideas and enhance student learning,"* (p. 2).

2.6.5. Barriers to technology in statistics

It is also key for students when using statistical software to understand how the results they obtain have been calculated, in fact it is of great importance to the results of data analysis for students to understand the steps in different processes if they are to gain a meaningful understanding of statistics. When teachers use technology to explain new statistical concepts, students also use technology such as statistical software programs to enter the data, make calculations and draw conclusions. These tools may be a 'black box' for students because they can't know what is inside and don't know how these tools process the calculations and analysis they undertake (Callingham 2011). This leads students to lose an important part of their learning, in terms of knowing procedures and the breakdown of steps in how results are achieved. This will negatively affect their understanding of statistical concepts (Chance et al. 2007). Thus, teachers should be careful when they use technology and how they use it with students. Furthermore, teachers have to explain the statistical software procedures and explore them with students (Chance et al. 2007).

The use of technology in teaching and learning statistics can add a new style to learning and motivate students to study, this does not occur until students are trained on the use of this technology gradually, in a way that is commensurate with their abilities. When students use any statistical software program, especially for the first time, they will focus their attention directly on how to use this program causing students to possibly lose some essential elements of their lesson focused on content knowledge. They may fail to understand the statistical idea which was the main goal behind using the program. To solve this problem Chance et al. (2007) mentioned that *"Teachers therefore need to carefully structure explorations so that even while learning to use the software, students are able to focus on the concepts rather only paying attention to the technology or blindly following a list of commands,"* (p. 16).

It is necessary to take into account that the technology may break at any time, which may cause interruption to learning and teaching. Internet services may not be available, computers may crash and the statistical software program may not operate. Therefore, according to Chance et al. (2007) *"teaching with technology means having a plan in case the technology fails during class. Contingency plans include making handouts of the planned lessons or transparencies revealing the expected outcomes,"* (p. 18). Furthermore, the use of technology in statistics and probability may lead to unexpected results, so it is important that teachers and students are comfortable with this situation and indeed, this can be an opportunity to open up discussion and interaction with students to explore why unexpected results might have occurred.

The use of technology as a tool to explore new concepts with attractive methods and the use of a software program to do the statistical operation with high efficiency and less time can make students think that there is no benefit from the time spent in the classroom. Some students may also think that these technologies can take the place of teachers – a clear misconception (Chance et al. 2007).

In some institutions, there is a lack of technical staff to support the use of technologies being used for teaching. Therefore, it is more important to focus on teacher training to use this technology and help teachers to implement these tools within statistics courses. This requires the availability of two main things: technical staff to train and support teachers on the best use of technology tools during their teaching and teachers must spend more effort and time to be trained on how use these technologies to give students the best experience (Chance et al. 2007).

2.7. The impact of language in learning and teaching Statistics

Usually, each particular discipline has specific words that are alien to junior students and people who are unfamiliar with the discipline. Many students who learn subjects in a second language face some difficulties with the language. Furthermore, resources and tools which are used in the study of disciplines such as statistics are often not available in languages other than English (Kaplan et al. 2009). With these barriers, students may face difficulty in their courses based on their ability or inability to overcome these problems.

2.7.1. Statistics terminology

The language which is used in teaching statistics is important in helping students to understand statistics courses. The use of terminologies in statistics with beginner students, particularly non-English Speaking Background students (NESB) who have limited language skills, may lead these students to believe statistics courses are more difficult than they really are (Kaplan et al. 2009). Furthermore, there are some technical words of statistics that do not exist in all languages and some of them are not fully explained in dictionaries as new students need (Abdelbasit 2010; Hubbard 1990). These obstructions may lead some students to believe that statistics is a difficult and complex course. Moreover, in statistics there is often more than one meaning indicated by a word and in addition, there are several words used to imply one meaning, and this can add to student confusion. For instance, teachers tend to use 'normally' and it is not necessarily related to 'normal distribution', but to a more general meaning. Also teachers use 'average' and sometimes 'mean' to relate to the same concept and this can be confusing (Barwell 2005; Kaplan et al. 2009). As a result, Kaplan et al. (2009) mention that *"The use of domain-specific words that are similar to commonly used English words, therefore, may encourage students to make incorrect associations between words they know and words that sound similar but have specific meanings in statistics that are different from the common usage definitions,"* (p. 2).

2.7.2. English language at non-English speaking universities

With the extensive use of English in the world, most researchers and writers tend to use English in their publishing; this has made English language the language of science worldwide. Therefore, many non-English speaking universities, especially in developing countries, encourage the use of English language as a main language in their institutions (Abdelbasit 2010). Statistics is one of the disciplines which uses the English language for two reasons: the lack of statistical resources in other languages - and for this study a lack of resource in the Arabic language is an issue - and also most of the software statistics software programs are in English. Thus, the use of English language in teaching statistics is an important factor to help students to understand statistics as Abdelbasit (2010) argued in speaking about University education in Oman, *"It is thus believed that teaching in the local language is disadvantageous to graduates. At Sultan Qaboos University (SQU) students are required to achieve a specified level in English (about 4 IELTS score) before they can start their science courses,"* (p. 1).

There are many difficulties which may face students when they use the English language in their studies that teachers need to consider. One of these difficulties is that students need more time in lectures to understand the subject and this may cause the loss of students' attention, and students tend to focus on their marks and exams rather than on understanding the subject. Accordingly, this difficulty may force students to follow a surface approach in their learning rather than a deep approach. Furthermore, students in many countries rarely use English outside the classroom, so their level of English language does not improve as much as those students living in English-speaking countries. Therefore, English language could be an encumbrance for these students rather than a help to them when they avoid studying in the local language (Abdelbasit 2010).

NESB students have an ability to read English statistics textbook and perhaps this has prevented some writers from writing statistics textbooks in local languages. Even where some statistics books are available in local languages, some difficulties remain in translating technical terms. Real-life examples used in statistics textbooks can help students to understand more clearly the new statistics concepts. However, many of these books, which are written in English, have included examples that are alien to students from other cultures; Abdelbasit (2010) writes that *"Students do not have a feel for baseball, golf, opinion polls, stock market shares, advertising research, dog sled racing and examples involving topics like belief in afterlife,"* (p. 2). As a result, students may not listen to their teachers, do not read the book, and they do not pay attention to the lecture, so this will negatively affect their studies and students may directly lose interest of this subject.

With all of these obstacles for students, teachers using English language in teaching statistics will face difficulties due to the language challenges experienced by many students. Preparation of the lecture, explaining the lesson in the classroom, focusing on students' comprehension, homework correction, preparation of final exams and collection of the results: all of these are considered a burden on teachers. Moreover, teachers have to spend more time to overcome the difficulties which face students in each of these learning areas, which increases the burden on teachers. In addition, when teachers spend more time on these problems, this will affect the time available for teachers' research, which is considered a key factor within world university ranking. Therefore, based on these difficulties and the limited time allocated to statistics courses for non-specialist students during the semester, it has been argued that the concentration and attention of teachers will be on completing the contents of the course rather than how best to teach courses to students (Abdelbasit 2010).

2.7.3. Diversity of students in the classroom

In recent years, there has been an increase in the number of students who study outside their home country, and the number could reach three million students (Rienties et al. 2012). This will certainly lead to a diversity of cultures in institutions and classrooms of higher education. For this reason, most of the non-English speaking universities have tended to use English language as the teaching language in their institution and English speaking universities have focused on providing English language programmes and courses for international students (Blignaut & Venter 2002; Hubbard 1990; Rienties et al. 2012).

Students have difficulties with all academic language skills: reading, writing, listening and speaking, as several studies have indicated, and these difficulties are more challenging for NESB students (Coutis et al. 2002). Moreover, Hubbard (1990) argues that *"statistical texts and lecturers tend to use the formal, concise language of mathematics to explain the theory of the subject,"* (p. 516). Hubbard (1990) proposed some comments which may help both NESB and English Speaking Background (ESB) students. Firstly, enhancing the availability of lecture recordings, although according to Arenas (2009) that may encourage students not to attend the lectures. Secondly, lecturers should speak slowly and clearly for the benefit of local and international students. Finally, teachers should provide their students with lecture notes, outlining the subject and all that is expected of their classes. The availability of these facilities may encourage students to adopt a deep approach instead of a surface approach in their learning, through encouraging students to continue their learning rather than their learning being limited to what teachers say.

The number of international students studying outside their home country has increased in the world. Recently, the percentage of international students has been 14% of the number of higher education students in UK and 20% in Australia, also there are more than half million students in USA (Rienties et al. 2012; Rose-Redwood 2010). Therefore, another social issue that may face students, especially in developed countries, which have more international students, is the growth in the diversity of cultures in the classroom as Arenas (2009) mentions *"growth in international education is not without challenges,"* (p.

615). The educational background of international students, belief, skills and competences all influence the student's integration in higher education (Rienties et al. 2012). These students not only need to integrate academically to be successful in their studying, but they also need to participate in the culture of other students both outside and inside the learning environment. A previous study among 900 international students in Australia indicates that 41% of them suffered homesickness, culture shocks and perceived discrimination. Therefore, social integration at university is very important for students' success. Rienties et al. 2012) cites Wilcox 2005, who found that *"social support by family and friend (i.e. social networks of students) has a positive influence on the study-success of first-year students,"* (p. 687).

In some cases, local students do not communicate with other international students as Hubbard (1990) said: "*In particular I have observed that the overseas students rarely mix with Australian students. They are almost always to be seen, both in classes and around the campus alone or with other overseas students,"* (p. 516). Blignaut et al. (2002) and Hubbard (1990) propose that teachers have the best methods to overcome this problem by involving students in group or collaborative work. The benefit from this approach is that students will be required to work with peers from different cultures.

What is clear with these difficulties is that the use of English language may adversely affect teaching and learning statistics, so there are some suggestions that may help to get over these difficulties. Firstly, the need to write statistics textbooks in English, which should contain examples and exercises from students' local cultures, also the need to expand authorship and translation of the statistics books from English language to different languages that may help students to study statistics whether in English or local languages (Abdelbasit 2010). Secondly, teachers should ask students whether they understand new words before using them because that will help teachers to judge students' understanding, and will also help students to give their attention to this word and the concept being taught. Also, teachers need to explain concepts slowly in the lectures when they teach or solve problems and teachers should create a list for statistical words which contain the exploration and explanation of these words which can be a useful basis for student's understanding. Finally, teachers need to speak with students regularly and give students an opportunity to speak and listen in English and to correct them when necessary, which will help raise their interconnection with peers and with the classroom activities, and contribute to raising students' confidence during lectures (Coutis et al. 2002; Kaplan et al. 2009). However, the benefit of this communication is not only for students as Arenas (2009) mentions, *"all* *stakeholders may improve their experiences: for teachers, to clearly articulate what they want students to know and effectively monitor students' progress; and for students to critically gain the knowledge,"* (p. 624).

The main difficulty which has faced international students is integration into the culture; group activity is a useful way to overcome this problem. Using a collective learning approach to increase the communication among students is an important factor to encourage them to support each other in the classroom and could help international students to overcome their limitations of cultural background and language (Hubbard 1990). The implementation of these proposed approaches are important to motivate students in their studies, especially in the study of statistics, but they also underline the importance of interactivity in learning environments that supports a student-centred approach.

2.8. Learning and teaching Statistics in different countries

Several research studies aim to review and report the situation of statistics in different countries, and indicate similar difficulties in statistics education (Tishkovskaya et al. 2012). For instance, several developed countries warn of the existence of deficiencies in the number of statisticians in industry and a decline in statistics teachers who teach statistics courses in universities. Some researchers have pointed out this issue, such as the report of the National Science Foundation on the US statistics profession, conducted by Kettenring, Lindsay, and Siegmund (2004); the review sponsored by Statistical Society of Australia Inc (2005) and the International Review of Mathematical Sciences (2010).

In Australia, the unenviable situation that is facing mathematics and statistics has been pointed out by two important reviews: Statistical Society of Australia Inc (2005) and Australian Academy of Science (2006). According to the Australian Academy of Science (2006),*"the number of mathematics and statistics students and lecturers at Australian universities is critically low,"* (p.8) and *"the nation's capacity to support research, research training and advanced education in mathematics and statistics is diminishing rapidly,"* (p.8). Furthermore, the review conducted by Statistical Society of Australia Inc (2005) highlighted the limited number of PhD students and how this would lead to a failure to meet the needs of academia and research-based institutions in Australia, as the state of statistics continues to decline in Australian universities. At this time, there are very few statistics departments in Australia, while these departments have found difficulty in filling vacancies for professional statisticians (Tishkovskaya et al. 2012).

In the USA, Kettenring et al. (2004) indicated that growth in the number of people specialising in statistics is not keeping pace with growing demands for statisticians in various sectors (such as industry, health, government and education) in the country. Although with the huge potential for the field of statistics, the research points out that there are three indicators that show the state of statistics in the US is compromised: limited resources, restrictions in the infrastructure supporting this field and low interest in statistics from students. Accordingly, the American Statistical Association (2007); Aliaga et al. (2005) and some senior researchers in statistics education such as Cobb (2007) and Rossman (2008) stress that the way in which statistics teaching is conceived of and taught needs to be reformed.

In New Zealand, statistics is considered a critical subject by educators where they encourage the use of new methods in teaching statistics in order to facilitate statistical understanding in simplified and new styles (Wild, Pfannkuch, Regan & Horton 2011). One study conducted by Wild et al. (2009) in New Zealand indicated that the inequitable educational outcomes that are obtained in statistics courses was due to the use of a traditional approach in teaching statistics. The Ministry of Education is encouraging the use of new approaches to teaching statistics such as investigative enquiry and integrating conceptual understanding within the new statistics curriculum (Ministry of Education 2007). Groups of consultants worked on curriculum development for several years. Allocated sections for statistics have been increased in the new curriculum, and 'Mathematics and Statistics' became the new name instead of 'Mathematics' where statistical literacy, statistical investigation and probability are involved. These new curricula support the use of new approaches in statistics and highlight the need for changes in both thinking and pedagogy. Furthermore, increases in the number of internal and external programmes in statistics is one of the contributions of the national statistical office (Statistics New Zealand) in the last few years.

In the UK, there are several studies that have reviewed and examined the current state of teaching statistics in universities. One study conducted by Smith & Staetsky (2007) highlighted questions about the situation of statistics in the UK identifying the potential obstacles that may face the statistics departments in universities. The researchers concluded that the number of statistics staff is decreasing in universities around the UK, and is continuing to decline. The authors mentioned that based on the study, they expected a decrease in the number of statistics staff in the mathematical sciences somewhere between 7% and 22% by 2010.

In China, one paper written by Jili & Yong (2002) describes the evolution of statistics education in China in recent years. After statistics became an independent specialisation, many difficulties have emerged such as how to design statistics, how teachers of statistics should be trained and how to teach students. This led those who are interested in statistics education to hold meetings and workshops to discuss those issues to help develop statistics education in China. The authors mentioned that in the early 1990s it was not easy for statisticians to find a good job and that led to a decrease in the number of graduates of the statistics specialty from 3546 in 1996 to 2296 in 2000. However, at the end of 1990s the awareness of the importance of statistics had increased in China where good jobs for statisticians had been created, as evidenced by the increasing number of specialist students who are on campus from 9616 students in 1996 to 12,803 in 2000. As a result of this development, Jili and Yong pointed to the need for more senior statisticians in China to keep up with the huge demand. The situation is similar in the Philippines; Bersales (2010) mentioned that the year 1953 can be called the birth date of statistics education because the Statistical Training Center was established by the Board Directors of the Philippine Statistical Association. The colleges offered only a few basic statistics courses and there were no academic programmes in statistics. However, development in statistics teaching continued from that time to the present where there are currently nineteen colleges and universities offering various academic degrees in statistics at university level. However, Bersales (2010) highlighted some of the previously mentioned difficulties which are facing the statistical teaching in the Philippines, including the lack of availability of good books, lack of professional teachers in statistics, inadequate technology facilities, the lack ofavailability of statistical software programmes and the continuity in the use of traditional methods in teaching statistics that do not enhance students learning.

In African countries, several studies have been conducted to identify the reality of the teaching and learning statistics in these countries. One study conducted by Opolot-Okurut, Opyene-Eluk & Mwanamoiza (2008) illustrated the situation of statistics education at different levels of study (primary, secondary and tertiary) in Uganda. The main points in this paper focus on the reform of mathematics curricula in Uganda and the adding of some statistical topics to these courses as well as customising independent statistics courses at university. However, they mentioned that the low socio-economic situation for the majority of people affects the educational process through the limited availability of facilities for both teachers and students. Additionally, the preparation in mathematical concepts at schools level is inadequate, thus students bring their anxieties toward the subject with them to the university. Furthermore, the authors highlighted three main challenges of teaching statistics in schools; the lack of mathematics and statistics teachers, students' attitudes toward mathematics and the lack of availability of resources and suitable textbooks. These challenges correspond with those challenges of teaching statistics in university level, which are mentioned earlier. Moreover, teachers in schools do not have full knowledge about the contents of statistics courses at university and that leads to a lack of knowledge of what preparation students need and what students are going to do. At university level, the researchers pointed out that teachers have used the traditional approach in teaching statistics in introductory statistics courses with very little discussion and interaction because of the large numbers of students in the class. It is not easy for universities to overcome these problems as there is a lack of qualified teachers. In any case, the results of this study do not differ greatly from findings in other studies in African countries such as Nigeria (Ogum 1998), Kenya (Odhiambo 2002), and Lesotho (Polaki 2006).

With the rapid spread of the statistics discipline and the emergence of its importance in various fields, the development of statistics is very different in countries across the world. In statistics education, research, workshops and conferences that focus on teaching and learning statistics are unevenly spread among countries. In developed countries such as United Kingdom, United States and Australia, there is a high concern given to the statistics education field, as seen through the number of journals, research projects, conferences and academic programmes. Conversely, in Arab countries (that would not be classified as developing nations due to their relative wealth), the situation is quite different as there are shortages in statistical research that would help Arabic countries to identify the strengths and weaknesses in this area necessary in order to develop statistics education further, as Innabi (2014) has stated, *"Another components necessary to activate this shift in Statistics Education in the Arab World is research. Very little research on statistics has been conducted in the Arab world. Considering that research is a vital factor for the real changes and real reform, there is an urgent need in the Arab countries for research on teaching and learning statistics, particularly concerning the tools and strategies that can help teachers help their students to become statistically literate,"* (p. 2).

2.9. Summary

Based on the existing literature in the field of statistics education, several factors relevant to the current research come to light. One of these factors is determining the appropriate approach for teaching statistics to non-specialist students at university level. It is also important to decide what non-specialist students should learn from statistics courses and these courses should be relevant to students' main subjects. The influence of technology use in learning and teaching statistics to non-specialist students is also considered an important factor. Moreover, the impact of English language in learning and teaching statistics to non-specialist students must be assessed; especially for those whose main language is not English, as is the case in Saudi Arabia.

Despite the emergence of statistics education as an independent discipline and the willingness of researchers around the world to discuss the important factors within this scope, there is a lack of statistics education research in Arab countries as Innabi (2104) mentioned. Furthermore, the researcher did not find any study in the scope of statistics education conducted in Saudi Arabia. Because of the importance of this discipline and the limitations existing in Saudi Arabia, the researcher was inspired to conduct this study in order to contribute to bridging the gap through taking a first step in the development of this type of research.

Chapter 3. Research Methodology

3.1. Introduction

The aim of this chapter is to describe the research procedures and methodology used in this study. The first section discusses the research methodology used; then the data collection methods and processes are explained in more detail before outlining the data analysis methods used. The purpose of this research was to generate new knowledge by investigating how statistics courses are currently taught to non-specialist students in Saudi universities. Thus, the study aims to answer the following research questions:

1. How are statistics courses for non-specialist students taught currently in Saudi universities?
2. What are the main challenges that face those teaching statistics to non-specialist students in Saudi universities and how have these been overcome?
3. What are the main challenges that face non-specialist students learning statistics in Saudi universities and how have these been overcome?
4. How could teaching practice in Saudi Arabia be enhanced to reflect appropriate developments in the rest of the world in teaching statistics to non-specialists?

3.2. Research design and methodology

The purpose of research determines the methodology of research; therefore there is no one correct approach to research design (Cohen, Manion, & Morrison 2013). This study aims to identify the current approaches to learning and teaching statistics for non-specialist students in Saudi universities. Thus, a descriptive methodology has been adopted that utilises survey research, but that is also informed by a more qualitative approach, hence mixed methods of data collection and analysis have been used.

To answer the research questions set out above, appropriate research methods were selected to gather the necessary data, and these are described and justified below.

In terms of data collection, the two main stages of the study were as follows:

1. The first stage was collecting data from non-specialist students who have completed at least one statistics course in Saudi universities to explore: how statistics courses are taught at those institutions, what challenges the students

face, and how the course should be run. These data were intended to help answer research questions one, three and four.

2. The second stage involved gathering data from teachers who teach statistics courses to non-specialist students in the same Saudi universities. These data were collected through semi-structured interviews, providing data from the other side of the process in teaching statistics courses. The current situation of teaching statistics courses, how these courses are taught and the challenges that may face both teachers and students were covered by the interview questions. These data are intended to help answer all four research questions. Both stages were carried out between 1st September to 30th December 2013

According to the methods used in educational research, Best (1970) claimed that *"descriptive research is concerned with how what is or what exists is related to some preceding event that has influenced or affected a present condition or event,"* cited in Cohen et al. (2013). Therefore, an exploratory descriptive research design was used that emphasised examining the rationales behind teachers' approaches to teaching as well as students' experiences of learning statistics and the specific needs of non-specialist students in the current Saudi context. .

The mixed methods approach that is used in this study enhances the scope and nature of the descriptive data gathered. Quantitative data allows the researcher to gather information from a large number of participants while qualitative data provides in-depth information from a smaller group of participants. To increase the quality and validity of the final results and to achieve richness of data from different perspectives, mixed methods are the most appropriate approach. Both quantitative and qualitative data complement each other in this study. Firstly, data collected about the views of students are quantitative (questionnaire) with some open-ended questions and, secondly, data collected about the views of teachers are qualitative (semi-structured interviews).

3.3. Research approach

This section explains the quantitative and qualitative approaches. After that, the mixed methods approach will be discussed to illuminate its suitability for this study.

3.3.1. Quantitative approach

Quantitative research, as defined by Muijs (2004) is *"explaining phenomena by collecting numerical data that are analysed using mathematically based methods (in particular statistics),"* (p.1).

The most popular methodological approach to quantitative research, widely used in educational research, is the survey (Cohen et al. 2013). Surveys are most commonly associated with using questionnaires as the data collection technique for gathering numerical data. The questionnaire has several characteristics and features that distinguish it from other tools. Data can be collected from a large pool of participants, numerous issues can be included and Cohen et al. (2013) argue that the data can be analysed more scientifically than data collected using other methods.

Because one of the main aims of this study was to find out how statistics courses are currently taught to non-specialist students, a questionnaire was selected as an appropriate collection tool. This questionnaire was designed to gather data related to research questions one, three and four. However, the qualitative approach is also used in this study, as a quantitative approach cannot provide all of the data required to properly answer the research questions.

3.3.2. Qualitative approach

A qualitative research method is defined by Dawson (2002) as one which *"explores attitudes, behaviour and experiences through such methods as interviews or focus groups. It attempts to get an in-depth opinion from participants. As it is attitudes, behaviour and experiences which are important, fewer people take part in the research, but the contact with these people tends to last a lot longer,"* (p.14-15).

Through the flexibility of the interaction between the researcher and participants that characterizes qualitative methods, participants have the opportunity to respond with some freedom (Mack, Woodsong, Macqueen, Gust, & Namey 2005). Thus, a researcher can obtain in-depth information about specific topics. Sahu (2013) argues: *"Mostly this is a conversation-based interview in which an interviewer concentrates on getting information from the respondent about the subject in which the respondent has enough experience,"* (p.65). Moreover, the flexibility includes allowing the researcher to ask additional sub-questions – for instance, 'why' or 'how', to gain new information or a deeper understanding of the processes at work (Mack et al. 2005).

One of the most common types of qualitative data collection methods is the interview. Interviews were selected for this study as an appropriate method to collect data from teachers who taught statistics to non-specialist students in Saudi universities.

3.3.3. Mixed methods approach

There are obvious differences between quantitative and qualitative methods. In quantitative research, a deductive process is followed: numerical data are generated, trends and relationships are traced, large samples of participants can be researched, the data are analysed using statistical methods and the results are more formalized. Conversely, in qualitative methods, an inductive process tends to be followed: non-numerical data are collected (for example, the reasoning and opinions of participants), research can be conducted within a small group of participants to obtain in-depth information, and the data are analysed by evaluating and synthesising words and themes (Punch 2009). One of the clearest differences between these methods is flexibility. Taking questionnaires as examples of quantitative methods, all participants are asked the same questions in the same way, and their responses are specified and fixed. Thus, the responses are equivalent, allowing the researcher to formalize comparisons and significant results. Conversely, taking semi-structured interviews as an example of qualitative methods, spontaneity is achieved between researcher and participants because most of the questions are 'open-ended' and it is not necessary for them to be asked in exactly the same way. Participants can think more closely about how to answer questions, while in the questionnaire they must follow the expectations of its compiler (Mack et al. 2005). Punch (2009) defines the mixed methods approach to research as *"empirical research that involves the collection and analysis of both qualitative and quantitative data,"* (p. 288).

Where quantitative methods can be useful in some studies, qualitative methods may not be. On the contrary, where quantitative research can be a weak approach in some areas, qualitative can be strong. Each method – quantitative and qualitative – has strengths and weaknesses (Punch 2009), depending on the research questions that are to be answered. Therefore, the combination of both quantitative and qualitative approaches utilizes the strengths of both methods, while attempting to compensate for and minimize the weaknesses of each of them (Bryman, Becker, & Sempik 2008; Punch 2009).

In this research study, mixed methods have been selected in order to obtain a range of information offering a better understanding of the experience of learning and teaching statistics in Saudi Arabia at university level. The data collected via questionnaires and interviews in this study complement each other and contribute to informing a more comprehensive conclusion based on the available evidence (Miles & Huberman 1994).

3.4. Data collection methods

Many statistical studies use secondary data analysis where another researcher has collected the data prior to statisticians commencing their research. However, in this study I have collected primary data due to the lack of existing data relevant to the research questions. This study used two types of data collection instruments. Questionnaires have been chosen to collect data from students and interviews to collect data from teachers. This section will describe both of them in more detail.

3.4.1. Questionnaire

This study aimed to survey a wide range of non-specialist students in Saudi who have completed at least one course in statistics in order to gain a realistic picture of how effectively statistics courses are taught. Several factors encouraged the researcher to select this type of data collection method in order to obtain standardised information from the sample and accurate results that can be generalized beyond the study population. The sample in this study includes over one thousand non-specialist students. Thus, a questionnaire is the most appropriate method to collect data from such a large population group (Cohen et al. 2013). Moreover, this study involved forty-one items that attempted to address the research questions, and Oppenheim (1992) argues that the most suitable technique to collect this volume and range of data is a questionnaire.

Obtaining rigorous results will depend on the quality of data and the most important factor that affects quality in this instance is the data collection approach. To ensure quality, participants should first be fully informed about the aims of the research, and be aware that the research cannot be completed without their cooperation. Secondly, to control the data collection process, the researcher should be present in person to collect data instead of leaving others to distribute the questionnaire (Punch 2009).

One of the most comprehensive definitions of the questionnaire, which includes all its basic elements and methods of distribution, is provided by Payne and Payne (2004) *"Questionnaires are the printed sets of questions to be answered by respondents, either through face-to-face interviews or self-completion, as a tested, structured, clearly presented* *and systematic means of collecting data (mainly in the quantitative methods tradition),"* (p. 186).

The researcher must have clear research questions before starting to develop a questionnaire. The first step is to have an obvious conceptual map of the questionnaire; this map needs to work from more general variables before moving on to more specific variables. After that, items and specific questions can be developed (Punch 2009). Many researchers, such as (Cohen et al. 2013; Fellegi 2003), have stated that the researcher should know what data the questionnaire will provide, and have an awareness of the design that is the most appropriate for participants. Simplicity in words and language should be used, helping participants to fully comprehend the questions. Precise wording should be used, where possible, to ensure both that participants understand the question and researchers can obtain the required information. Ambiguous questions should be avoided. Moreover, the researcher must be concerned with the size of the questionnaire to avoid respondent boredom which may affect the response rate; questions should be clear and concise. Questions that include double-negatives should be avoided to prevent possible confusion.

In addition, another important issue is the leading question; in other words, questions may lead a respondent towards a certain answer, so this type of question should be avoided. Sensitive, personal and threatening questions must not be asked in the questionnaire, though this circumstance is unlikely in this particular area of study. Moreover, questions that deal with more than one concept – double-barrelled questions – should also be avoided, again to prevent confusion. If all these conditions are met, the researcher has attempted to develop an appropriate questionnaire for their study, as is the case here.

Different kinds of questions and response patterns can be included in questionnaires (Cohen et al. 2013). The two main types are closed and open questions, and Fellegi (2003) defines them as: *"Closed questions are those where response categories are listed with the question,"* (p. 63) and *"Open questions are those where response categories are not provided to the respondent,"* (p. 62). Both types of question have advantages and disadvantages, which are discussed below.

The advantages of closed questions are that they do not require long answers, making responses more formulaic and data easier to analyse (Fellegi 2003). Moreover, closed questions generate frequencies of response and enable comparisons between groups of samples (Cohen et al. 2013; Oppenheim 1992). Some disadvantages of closed questions are: options and answers of questions are limited, so respondents can be forced to choose a response category that may not precisely correspond to their point of view (Fellegi 2003). Similarly, it is not possible for respondents to add remarks, further explanation or qualifications, which can cause bias (Oppenheim 1992). This study requires collecting diverse data in multiple areas of the teaching and learning of statistics for non-specialist students. Thus, mostly multiple choice and agreement scale questions were selected.

The second type of question is an open-ended question, and it has several advantages. Firstly, there is no choice of specific categories for respondents and they answer the questions without direct influence (Oppenheim 1992). In addition, with open-ended questions self-expression and elaboration are encouraged (Fellegi 2003) through respondents being able to use their own words to illustrate their responses when answering the questions (Cohen et al. 2013).

On the other hand, there are several disadvantages to open-ended questions in written responses. Irrelevant and redundant information may be obtained, especially when respondents are unaware of what the study requires (Cohen et al. 2013), thus, this may lead to difficulties in analysis (Oppenheim 1992). However, in-depth information is needed from non-specialist students to explain their viewpoint towards how statistics courses are taught and what they would like to change. Therefore, taking into account the relatively large number of students that the questionnaire was to be distributed to, the questionnaire in this study included a relatively small number of open-ended questions with spaces given for the students to present their viewpoints, suggestions and opinions.

In addition, one of the common components in questionnaires is matrix questions, which are not a type of question, as such, but more a layout of questions (Cohen et al. 2013). In a matrix question, the same response options are given to several questions, saving space in the questionnaire and allowing the respondent to choose answers quickly (Cohen et al. 2013). One matrix question has been used in the questionnaire. However, there is the risk of respondents simply selecting the same answer for each item by running down one of the columns (Baker 1993). Therefore in my study, I took the decision to state some of the questions in the negative form in order to identify any students who ticked all the boxes in one column and therefore had clearly not read all the questions correctly. Any questionnaires where the respondent had clearly not read the questions were removed from the data.

Furthermore, a covering letter is one of the most important components of questionnaires, the main purpose of which is to inform the respondents of the study’s aims, its importance and emphasis on the confidentiality of responses. Also, the title of the research, the researcher's name, organisation and contact address should be provided (Cohen et al. 2013). This study complies with these important guidelines about the covering letter (see appendix A for a copy of the covering letter).

In recent years, many researchers in statistics education have focused their research on the attitudes of students towards statistics (Chiesi & Primi 2009; Gal, Ginsburg & Schau 1997). Some questionnaires designed to examine students' attitudes towards statistics exist already, for instance the Survey of Attitudes Toward Statistics (SATS-36) (VanHoof, Kuppens, Sotos, Verschaffel & Onghena 2011). The instrument is developed to measure students' attitudes toward statistics through 36 items comprising six subscales. 1) *Affect:* positive and negative students' feelings concerning statistics; 2) *Cognitive Competence:* students' attitudes about their intellectual knowledge and skills when applied to statistics; 3) *Difficulty:* students' attitudes about the difficulty of statistics as a subject; 4) *Value:* students' attitudes about the usefulness, relevance, and worth of statistics in personal and professional life; 5) *Interest:* students' level of individual interest in statistics; and 6) *Effort:* amount of work the student expends to learn statistics. However, several studies (such as Chiesi et al. 2009; Dauphinee, Schau & Stevens 1997; Hilton, Schau & Olsen 2004) that used this instrument found that three of the subscales (*Affect, Cognitive Competence and Difficulty*) appeared to be very strongly correlated. However, these subscales were represented as three distinct latent factors (Vanhoof et al. 2011). Therefore, Vanhoof et al. (2011) proposed improvements to the instrument by removing some poorly functioning items and combining the three highly correlated subscales without losing much information. Although the SATS-36 instrument contains some concepts and aims that relate to the focus of this study several issues in learning and teaching statistics that arose from the literature review, such as the effectiveness of statistics teachers, the use of statistical software programs and the role of the English language, are not addressed in existing questionnaires such as SATS-36. Therefore, SATS-36 was not considered to be sufficiently focused on the research questions in this study to be appropriate to use. In the end, the decision was made to develop our own questionnaire for non-specialist students in order to address the specific research questions for this study.

3.4.2. The interview

The interview is one of most common data collection tools in qualitative research. It allows people to explore their ideas and opinions regarding specific phenomena in their own words. Jones (1985, p.46) reported that, *"in order to understand other persons' constructions of reality, we would do well to ask them ... and to ask them in such a way that* *they can tell us in their terms (rather than those imposed rigidly and a priori by ourselves) and in a depth which addresses the rich context that is [the] substance of their meanings,"* cited by Punch (2009) (p. 144).

Interviews have several purposes, and Cohen et al. (2013) highlighted the main three: firstly, an interview allows the interviewer to access the interviewee's perspectives. Secondly, it helps ask a range of questions that are directly related to answering the research questions and testing the hypotheses. Finally, it may be used to re-examine unexpected or anomalous responses from the questionnaire responses. Therefore, flexibility during the interview is important, participants should be allowed to express their thoughts and opinions (Bell 2005). Furthermore, greater clarification and understanding of particular responses can be obtained through the interviewer asking deeper questions (Cohen et al. 2013).

The importance of data collected in this way means that it is preferable to record each interview (Cohen et al. 2013). Tape recording is a reliable means for recording open-ended interviews, enabling analysis at any point (Cohen et al. 2013; Punch 2009). Recording also allows the interviewer to keep his attention on the interviewee, rather than taking notes (Bell 2005). All the interviews in this study were recorded using a digital recorder.

In this study, the interview was designed to gather information from statistics teachers in Saudi universities who teach statistics courses to non-specialist students. It was designed based on the issues that emerged from the literature, upon the main themes of the student questionnaire and overall in order to ensure all the research questions were answered. The interview questions cover the fundamental aspects of teaching statistics to non-specialists, which are: teaching methods, the development of statistics courses, the difficulties that may face teachers and non-specialist students in teaching statistics, using the PCAI framework (Pose the question, Collect the data, Analyse the data and Interpret the results) and the influence of technology and English language in teaching statistics.

3.5. Translation of the data collection instruments

The study took place in Saudi Arabia, where the first language is Arabic, but the instruments were drafted in English to allow them to be discussed in detail by the research team, as this research was being supervised in the UK. Consequently the questionnaire and the interview had to be translated into Arabic. During translation, it was important to ensure that the language was not ambiguous in either version, while maintaining the original meaning of the questions.

To ensure the validity of translation the initial translation from English to Arabic was made by the researcher. Then, two PhD students in UK universities whose native language was Arabic and who spoke English fluently were asked to proofread the translation to ensure the accuracy of the translation. These students have backgrounds in linguistics and mathematics education. The Arabic versions were adjusted accordingly. After that, the Arabic versions of the questionnaire and interview were sent to two experts in the Arabic language in Saudi Arabia for proofreading. Based on the comments of these experts, some grammatical points in the Arabic version were edited.

3.6. The pilot study

A pilot study is intended to test the reliability and validity of the questionnaire, and so is an important step before data collection (Cohen et al. 2013). Cohen et al. (2013) discussed how several researchers (Morrison 1993; Oppenheim 1992; Wilson & McClean 1994) have highlighted the following advantages of the use of a pilot study:

1. To ensure clarity and eliminate ambiguities in the questionnaire.
2. To gain feedback on the validity and level of readability of the questionnaire.
3. To gain feedback on the types of questions and layout of the questionnaire, and how appropriate this is for students.
4. To check how long participants will need in order to complete the questionnaire.
5. To identify the difficult, regularly non-completed and least understood items.

The pilot study of the questionnaire involved presenting the questionnaire to seventeen recent graduates who had been non-specialist students in Saudi Arabia and had completed at least one course in statistics, and one teacher of statistics in Saudi who teaches non-specialist students. The interview was also conducted with one statistics teacher to ensure that the questions maintained clarity. I conducted the pilot study, and feedback was collected directly from respondents. After that, I asked every participant if there was any ambiguity in the questions within the questionnaire, whether the questions were understandable, and whether they had any comments about the questionnaire (or interview). Based on the results of the pilot study, no changes were made since the questions were clear to the participants.

3.7. Sampling design

Typically, it is impossible to study every individual in a population in most research studies, especially if the size of population is large or unlimited. Time and resource constraints further limit the number of possible respondents. Instead, a sample of the population is taken to identify the characteristics of the entire population. When the characteristics of a sample can be extrapolated to the target population, conclusions may be drawn (Cohen et al. 2013).

The target population of the study is all non-specialist students who have completed at least one statistics course in a Saudi university, and statistics teachers. Because of resource limitations, data were collected from the eastern region of Saudi Arabia only. There are several reasons for selecting this region:

1. **Geographical reasons:** Within Saudi Arabia, the eastern region is considered the largest province and covers 33% of the entire area of the country (*Figure 3-1*). The population of the region is 4.1 million, which represents 15.6% of the country's total population. Furthermore, my home town is in this region, reducing resource costs. Therefore, the best place for the researcher to conduct the study was the eastern region.
2. **Social reasons:** Most of Saudi Arabia's oil is produced in the eastern region. Jubail City, which includes a global hub for chemical industries, is located in this region. It is also a regional agriculture and tourism area because of its proximity to the coast of the Arabian Gulf. As a result, the people who live in the eastern region represent a cross-section of Saudi Arabian society.
3. **Educational reasons:** In Saudi Arabia, there are two classifications of institutions that offer higher education. The first are twenty-four public institutions that are funded by the government – there is no cost for Saudi students who study at these institutions. The second classification covers private institutions that are owned by companies and individuals. There are nine private universities around Saudi Arabia; study at these institutions is not offered free of charge. Both types of institution exist in the eastern region. These institutions all teach statistics courses to non-specialist students.

Figure 3-1 The locations of the participants

3.7.1. Characteristics of the universities

Non-specialist students and statistics teachers in the eastern region's universities were the study population of this study. For the reasons listed above, it seems reasonable to assume that their responses can be extrapolated to represent the other universities in Saudi Arabia. The six universities in the eastern region, which represent 18.2% of all universities in Saudi Arabia and 100% sampling of universities in this region, were selected to obtain the most generalizable results (*Table 3-1*). 15 colleges, which are all the colleges within these universities, and 39 academic departments, offer courses where statistics is taught to non-specialist students (which comprise most of the academic departments within these colleges). A cluster sampling design was adopted, in which students and teachers were sampled from every college separately. A complete list of departments within colleges, and courses within those departments where statistics was taught, was identified based on the information and study plans that were available on their websites at that time.

Table 3-1 Details of Universities in Eastern Region

	Name of University	Classification	Usual Language of Study	City	Number of students
1	King Fahd University of Petroleum & Minerals	Public	English	Dhahran	8568
2	Dammam University	Public	Arabic	Dammam	40681
3	King Faisal University	Public	Arabic	Hassa	34430
4	Al-Imam Muhammad ibn Saud University (Al-Hassa branch)	Public	Arabic	Hassa	2500
5	Prince Mohammad Bin Fahd University	Private	English	Khobar	3800
6	Jubail Industrial College	Public	English	Jubail	3600

3.7.2. Sampling of teachers

I confirmed with the Deans of Colleges and the Chairs of Departments the names of teachers who taught statistics courses in their institutions at the time of conducting the study. From the list of statistics teachers in each institution, at least one teacher was selected randomly and I contacted him/her in order to set up an appointment to conduct the interview. Sixteen statistics teachers who taught non-specialist students were randomly selected from most of the colleges within these universities. *Table 3-2* summarises the sample sizes for teachers who participated in this research. Distances between universities, lack of time, and difficulty in scheduling an appropriate appointment with the teachers, were the most important causes of disparity in the numbers of teacher participants. This led to a limitation with the teacher interviews, where a single teacher represents the whole university at two of the universities within the study, creating a situation of potential bias.

Table 3-2 The Sample Sizes of Teachers of Statistics

Universities	Colleges where statistics is taught to non-specialist students	Teachers sampled (departmental affiliation)	
King Fahd University	College of Industrial Management	3	Department of mathematics and statistics (College of science)
	College of Computer Science		
	College of Engineering Sciences		
Dammam University	College of Education	1	Department of general studies (College of engineering)
	College of Engineering		
	College of Architecture & Planning		
King Faisal University	College of Business	1	Department of quantitative studies (College of business)
	College of Education	1	Department of psychology (College of education)
	College of Computer Science	1	Department of mathematics and statistics (College of science)
	College of Agricultural and Food Science	1	Department of home economics (College of Agricultural and Food Science)
		1	Department of environment and natural agricultural resources (College of Agricultural and Food Science)
	College of Engineering	2	Department of electrical engineering (College of Engineering)
Al-Imam Muhammad ibn Saud University (Al-Hassa branch)	College of Shariah and Islamic Studies	2	Department of computer science (College of Shariah and Islamic Studies)
Prince Mohammad University	College of Computer Engineering and Science	1	

	College of Business Administration		Department of mathematics and natural sciences (Deanship of core curriculum)
Jubail Industrial College	Mechanical Engineering Technology	2	Department of general studies (Jubail Industrial College)
Total		**16**	

3.7.3. Data collection procedures

- **Questionnaire**

Initially, the hairs of departments at each university read a sample of the questionnaire and the research proposal, and gave their permission for the study to be conducted in their institutions. Referring back to the list of all statistics courses in this department and in coordination with the chairs of these departments, one suitable section (class) from each academic department was randomly selected and all the students in that section were invited to be part of the cluster sample for the study. In accordance with the usual rationale for cluster sampling, this was seen as a more efficient way of obtaining an adequate overall sample size than sampling only a small number of students from each of a larger number of classes. In addition, it would have been awkward to exclude some students in a class while inviting their classmates to take part. The researcher set up appropriate times to visit the classes and contacted the teachers of classes at that time to obtain their permission to visit the classrooms and use the last 15 minutes of their lectures to distribute the questionnaires (see Appendix B) to students participating in the study.

In Saudi Arabia, lecture attendance is monitored and students would be disciplined if they were not attending regularly. Anecdotally, within Saudi Arabia 95% of students would be present in the class, so we can assume that almost all students would have been present when the research was carried out. Therefore, the study aimed to obtain a 100% response rate from the students present in these classes in order for this study to be as realistic and credible as possible. Secondly, the questionnaires were distributed during the last 15 minutes of lectures in these classes to try to capture the views of all the students who were present that day. However, I could not find out the total number of students who were enrolled in each of the statistics courses in these colleges and departments, so there is no way of knowing the sampling fractions achieved.

The salient points of the study were explained to the student participants, wherein: students who participated in the study had to have completed at least one course in statistics, participation was voluntary and they were to answer the questionnaire as realistically and honestly as possible. Finally, they were informed that all of the information in the questionnaires was anonymous and would be used for research purposes only. Questionnaires were distributed to every student in the classroom, regardless of the number of students, so that is the main cause of variation in the number of participants from each academic department. The researcher stood at the front of the room until the students had finished filling in the questionnaires, which the researcher then collected from them.

In total, 1078 students were present in the classes visited. However, seven of them did not want to participate, and 18 questionnaires that were returned were deemed unusable, as more than 50% of the questionnaire was unanswered, so those questionnaires were ignored in terms of analysis. *Table 3-3* gives further information about the 1053 students whose questionnaires were complete and whose responses were used in the research. The procedure explained here was for male students, while conducting the study with female students had to differ for cultural reasons which will be clarified later in this chapter.

Table 3-3 The Sample Sizes of Participants

Universities	Colleges where statistics is taught to non-specialist students	Subjects	Number of students	
			Male	Female
King Fahd University	College of Industrial Management	Finance	17	-
		Accounting	13	-
		Management	13	-
		Marketing	18	-
	College of Computer Science	Computer engineering	21	-
		Systems Engineering	29	-
	College of Engineering Sciences	Chemical Engineering	19	-
		Mechanical Engineering	16	-
		Petroleum Engineering	22	-
Dammam University	College of Education	Special Education	36	-
		Quran Studies	23	-
	College of Architecture & Planning	Building Science and Technology	22	-
		Urban & Regional Planning	24	-
	College of Engineering	Environmental	14	-
		Construction	27	-
King Faisal University	College of Business	Accountancy	23	27
		Business Administration	16	15
		Financial Sciences	39	-
	College of Education	Kindergarten	-	24
		Special Education	36	20
		Artist Education	18	-
		Physical Education	35	-

	College of Computer Science	Computer Science	22	20
		Information Systems	18	20
	College of Agricultural and Food Science	Animal and fisher production sciences	19	17
		Food and nutrition sciences	16	20
	College of Engineering	Electrical	10	-
		Civil	3	-
Al-Imam Muhammad ibn Saud University (Al-Hassa branch)	College of Shariah and Islamic Studies	Accountancy	39	-
		Management	28	-
		Geography	28	-
		Computer Science	11	-
Prince Mohammad University	College of Computer Engineering and Science	Information Technology	23	-
	College of Business Administration	Finance	23	15
		Business Administration	15	9
		Management Information System	16	11
Jubail Industrial College	Mechanical Engineering Technology	Accounting	38	-
		Marketing	37	-
		Information Technology Systems Support	28	-
Total			855	198

- **Interview**

Interviews were conducted with statistics teachers within colleges of each university where statistics was taught to non-specialist students. The researcher introduced himself to them and then set up suitable times to conduct an interview with each of them and told them that the interview might take 30 minutes for them to answer all of the questions. Prior to each interview, the teachers were asked to sign a consent form (see Appendix F). The length of time required to conduct the interviews varied from 20 to 30 minutes. All the interviews were recorded and transcribed in Arabic. However, the researcher requested assistance from a faculty colleague who has a PhD in translation from the United Kingdom, and he translated all the interviews from Arabic into English. There was one female statistics teacher at King Faisal University whose interview was not recorded for cultural reasons, where it was considered inappropriate for me to interview the female teacher on her own. However, I wrote the questions from the interview as open-ended questions and sent them to her via a female colleague who is my relative. When she had completed them, she gave them back to me with her consent form via the same colleague.

3.7.4. Difficulties

- **Transportation**

Transportation was the most serious difficulty that I encountered when collecting the data. My home city is Al-Hassa, which is 200 km from the cities that were visited: Dammam, Khobar and Dhahran. Also, the distance between Al-Hassa and Jubail City is nearly 300 km. Because of the lack of public transportation in these cities and between them, I had to travel to the universities and colleges in my own car. Also there was a great deal of wind and heavy rain in the Eastern region at that time of year.

- **Communication with female students**

In Saudi Arabia, male and female students are taught in separate classrooms at all levels of education (including elementary, high school, and higher education). This separation is not only in the classrooms but in the buildings and among members of the faculty. For cultural reasons, it was not easy for me, as a male researcher, to communicate with the females in university departments. Because of this limitation, the questionnaire was only answered by females in King Faisal University and Prince Mohammed University. King Faisal University is in my home city and I have some female relatives who work there and who helped me to access and communicate with female staff in the departments. In Prince Mohammed University, while I was conducting the study there were some of the male teachers who were very interested in this research and they offered to help me to communicate with female students. Therefore, I was able to conduct the study with female students in this university as well. So there was only one university (Dammam University) where I was unable to conduct the study with female students; the other universities do not offer higher education for female students.

- **Refusal to participate**

Only one statistics teacher refused to participate in the study. This teacher prevented me from distributing the questionnaire to the students in his classroom as well. Furthermore, although I had frequent contact with another teacher of statistics at Dammam University in order to try to set up an appointment with him, in the end, he did not find the time to participate in an interview. However, I conducted the interview with their colleagues in these universities, so these two teachers’ refusal to participate had little effect on the overall results.

3.8. Qualitative data analysis

There is no one correct way to analyse the data or present them; the method chosen must reflect what the researcher wants from analysis. Qualitative data analysis enables the researcher to identify the meaning of texts, interpret human behaviour, examine the substance of such behaviour and build a theory. Furthermore, qualitative data analysis helps themes, patterns and stories to emerge within research texts (Cousin 2009; Cohen et al. 2013).

The qualitative data from the students' questionnaires as well as the teachers' interviews covered different areas of the main research questions. There were six open-ended questions in the student questionnaire, which covered aspects of learning and teaching statistics. Related participants' responses were grouped and categorised in order to identify the students' points of view about these aspects. On the other hand, the teacher interviews were presented and analysed on an individual basis. Cohen et al. (2013) suggested that this way of organising the data helps the researcher to draw a clear picture from participants' responses. Thus, in the beginning all the interview transcripts were read in order to identify the key ideas appearing frequently; an inductive approach was used to analyse these data. Thomas (2006) defines inductive analysis as *"approaches that primarily use detailed readings of raw data to derive concepts, themes, or a model through interpretations made from the raw data by an evaluator or researcher,"* (p.238). Several researchers such as (Strauss & Corbin 1998; Miles et al. 1994; Punch 1998) indicated that the inductive approach is one of the common types of qualitative data analysis used in studies of this kind. Next, those ideas and issues which appeared together (question by questions) were grouped together in order to identify the main themes. Eight main themes were extracted from the teachers' interviews.

3.9. Quantitative data analysis:

The quantitative data from the students' questionnaires were analysed using Statistical Package for Social Sciences (SPSS) version 21 and R statistical software with the package 'lme4'. Several main sections were included in the questionnaire, so different techniques were used. Descriptive statistics (frequencies and percentage) were used to identify the demographic characteristics of the participants of the study. Items scales were grouped based on the main issues that were identified from the literature review, thus exploratory data analysis was used to explore the main pattern of association between students' responses and predictor variables with more details. The chi-square test is used as guidance to determine associations between questions and variables. Factor analysis is conducted for confirming the dimension reduction of variables (items scales) and to check the validity of question groups. Furthermore, because of the existence of clustering in the data (students within departments/ colleges, within universities), multilevel models are used to clarify the effects at those levels. Factor analysis and multilevel modelling are described in the following sections.

3.9.1. Factor analysis

In this study, there were many individual questions in the student questionnaire with substantial associations expected amongst them. It is difficult to understand the data and interpret the results with too many variables (Punch 2009). The questionnaire was designed to explore non-specialist students' opinions around particular themes, such as the use of technology, barriers caused by the use of the English language and the relevance of statistics courses to their main subject. Therefore, factor analysis was explored as a means to reduce the number of variables (Cooper 2002). Factor analysis investigates whether a large number of measured variables might be usefully considered to represent a smaller number of categories of unobserved variables, which are called factors. Furthermore, factor analysis can be used to determine the number of underlying factors, as well as which variables make up which factors (Cooper 2002; Punch 2009). The factors summarise the information contained within the original variables, but that does not mean the factors explain the correlation of the variables (Punch 2009).

Mathematically, the model of factor analysis (FA) can be written as follows:

If we have p variables $X_1, X_2, \dots, X_p$ measured on a sample of n subjects, the variable X_i can be written as a linear combination of m unobserved or latent factors $F_1, F_2, \dots, F_m$ where $m < p$. Thus,

$$X_i = a_{i1}F_1 + a_{i2}F_2 + \cdots + a_{im}F_m + e_i$$

Where the a_is are the factor loadings for variable i and e_i is the part of variable X_i that cannot be explained by the factors.

Fabrigar, Wegener, MacCallum, & Strahan (1999) proposed that there are five key points that should be considered when conducting factor analysis. First, the variables that are to be included in the study and the sample size. Second, researchers should determine whether Exploratory Factor Analysis (EFA) is the appropriate approach for analysis. Third, select the method to be used for fitting the model. Fourth, decide the number of factors that should be retained. Finally, select a method for rotating the factors (if appropriate). In the next few paragraphs, I will consider each of the second to fifth points in turn.

In connection with the second point, exploratory and confirmatory are two different types of factor analysis. When the researcher has a clear expectation about the number and structure of the factors, confirmatory factor analysis is the appropriate technique since it enables one to test that the expected relationships actually appear in the data. On the other hand, for cases in which the researcher has no clear predictions or expectations about the underlying structure of correlation (like the situation in this study), exploratory factor analysis identifies relationships among variables which are not obvious in the original data (Hutcheson, & Sofroniou, 1999). Fitting a model for exploratory factor analysis usually requires a choice between principal component analysis (PCA) and maximum likelihood (ML) (Fabrigar & Wegener, 2011). Each of these fitting procedures has particular advantages and disadvantages. ML allows a wide range of measures to be computed to judge the goodness of fit of the model, statistical significance testing of the factor loadings, estimation of the correlation among factors and construction of confidence intervals for these parameters. Its primary limitation is its assumption of multivariate normality and, when this is violated, ML can produce distorted results. On the other hand, no distributional assumption is necessary for the PCA method. Furthermore, producing inappropriate solutions is less likely with PCA than ML. However, providing only a limited range of goodness of fit measures and failing to provide a means for constructing confidence intervals and significance tests are the primary disadvantages of PCA (Fabrigar et al. 1999).

Fabrigar et al. (1999) pointed out that “data reduction involves taking scores on a large set of measured variables and reducing them to scores on a smaller set of composite variables that retain as much information from the original variables as possible … if the goal is data reduction, principal components analysis (PCA) is more appropriate” (p. 275). Therefore, Principal Component Analysis is used as the extraction method for FA in this thesis.

The fourth key point mentioned by Fabrigar et al (1999) is the choice of the number of factors to include in the FA model. In this thesis, the modelling starts by fitting a full FA model, containing as many factors as there are variables in the original data set. An eigenvalue is associated with each factor; it is proportional to the amount of variance in the data that is explained by that particular factor. The eigenvalues are plotted in decreasing order on a scree plot, so that a decision can be made about the number of factors to retain in the model; this is often chosen to be at a point where the scree plot flattens out but, alternatively, it might be decided that only factors with eigenvalues larger than 1 (the average value across all factors in the full model) will be retained. Finally, addressing the fifth point made by Fabrigar et al (1999), the factors are rotated so that, as far as possible, each variable loads mainly onto one factor. Orthogonal rotation, where the axes are kept at right angles and so represent uncorrelated factors, is used in this study; the other possibility is an oblique rotation, where the axes are not constrained to lie at right angles and factors are allowed to be correlated with each other. It should be noted that the goodness of fit of the overall factor model is not influenced by rotation. Furthermore, the total percentage of variance explained by the factor model does not change (Hutcheson, et al. 1999). The Rotated Component Matrix table is consulted to find out which variables load onto which factors. Then appropriate nomenclature can be formulated to describe each factor (Brace, Kemp & Snelgar 2006). The Statistical Package for Social Sciences (SPSS) is used to execute this stage of the analysis.

The Kaiser-Meyer-Olkin (KMO) measure will be used to check that the final factor analysis model explains a useful proportion of the variance in each measured variable. The KMO measure can be calculated for individual (3.1) and multiple (3.2) variables using the following equations:

$$\frac{\sum_{i\neq j} r_{ij}^2}{\sum_{i\neq j} r_{ij}^2 + \sum_{i\neq j} a_{ij}^2} \qquad (3.1)$$

$$\frac{\sum\sum_{i\neq j} r_{ij}^2}{\sum\sum_{i\neq j} r_{ij}^2 + \sum\sum_{i\neq j} a_{ij}^2} \qquad (3.2)$$

Where r_{ij} is the simple correlation coefficient between variables i and j; and a_{ij} is the partial correlation coefficient between variables i and j. The model is generally seen as adequate if the value of the KMO test is greater than 0.5 and values closer to 1 are better (Brace et al. 2006). Also, an anti-image matrix of covariance and correlations will be used. The diagonal values in the anti-image correlation matrix are the KMO values for each variable and all elements on the diagonal should be greater than 0.5 if the model is adequate. The off-diagonal elements of this matrix identify the pairwise correlations between variables. (Brace et al. 2006). Bartlett's test of sphericity checks for the availability of redundancy in the variables that might allow them to be summarised by a small number of factors. The test compares the underlying population correlation matrix to the identity matrix. The null hypothesis is that the correlation matrix is an identity matrix (all diagonal elements are 1 and all off-diagonal elements are 0), which would indicate that the variables are unrelated. If the significance value for this test is less than 0.05, the null hypothesis that the correlation matrix is an identity matrix will be rejected and it must be concluded correlation exists between variables. This test indicates that the data are potentially factorable if the test is significant.

A general criticism of factor analysis is that, if the study were repeated with a new sample of data, we might obtain a model with the same number of factors but the actual loadings would change. Furthermore, with different fitting methods and different rotations, we might obtain different loadings even using the same dataset.

Although, theoretically, factor analysis was developed to explore items with continuous responses, it is very commonly used for categorical or ordinal data of the sort we have in this study. This is one aspect of a general question, is it appropriate to treat Likert scales as continuous responses and use the data in parametric statistical procedures that require interval-scaled data, such as Linear Regression or Factor Analysis? One camp maintains that, as ordered categories, the intervals between the scale values are not equal and any numerical operation applied to them is invalid. This group stresses that only nonparametric statistics should be used on Likert scale data (see, for example, Jamieson, 2004). On the other hand, the other group maintains that while technically the Likert scale item is ordered, using it in parametric tests is valid in some situations. For instance, Lubke & Muthen (2004) found that it is possible to obtain accurate parameter estimates in factor analysis with Likert scale data, if limited assumptions about skewness, number of categories, etc., were met.

3.9.2. Multilevel modelling

In many studies, data exist in a hierarchical, nested or clustered structure; this is particularly true of data in social research (Goldstein 2011). Traditional multiple regression techniques are based on assumptions in the analysis of data. One of the most important assumptions is that there are no relationships among the individual data of the dependent variables (Finch, Bolin, & Kelley 2014). In other words, this technique ignores the clustering of data and their grouping where it exists. Overlooking any relationship amongst the data can lead to an increased risk of drawing erroneous conclusions (Heck & Thomas 1999; Rasbash, Steele, Browne & Goldstein 2015). For example, the study of children in primary schools, carried out in the 1970s by Bennett (1976), claimed that the 'formal' style of teaching reading affects children's achievement compared with those who received the informal style of teaching, and the results of this research were statistically significant when traditional multiple regression was conducted (Goldstein 2011). Later, Aitkin, Anderson, & Hinde (1981) pointed out that, when the grouping of children into classes is considered, the significant differences in the outcomes disappear (Goldstein 2011). Therefore, multilevel modelling techniques overcome the issues of clustering because the nesting of students within classes and the nesting of classes within schools are considered (Goldstein 2011).

The multilevel approach enables researchers to measure the effect of each level (in this research, student, college and university) by considering the variables' variance separately in the different levels. Finally, better estimates for the variance of standard error are achieved (Goldstein 2011; Jahan 2012).

The data in this study have a clustered structure. 1053 non-specialist students who have participated in this study, nested within 39 academic departments, within 15 colleges – and the colleges grouped into 6 universities. Furthermore, in many applications, the outcome variable of interest is categorical rather than continuous, as is reflected in the outcomes of this study. Although, the outcome variable is ordinal (on a five-point Likert scale), the sample size of the study is insufficient to run the multilevel generalized linear model for an ordinal outcome. Therefore, outcome categories were grouped appropriately so that the multilevel generalized linear model for dichotomous outcome variables, which is also called multilevel logistic regression, could be used in this study, with a three level structure (student, department or college, university). Department and College were included separately as levels in the model in order to identify their effect on students' responses and to ensure that the model selected is the most appropriate model. However, transferring the outcome variables from ordinal to binary might cause the loss of a lot of information. Therefore, the outcomes were re-categorised in two different schemes in order to check whether the results were substantially different. The first scheme is (Strongly agree/ Agree against Neutral/ Disagree/ Strongly disagree) and the second way is (Strongly agree/ Agree against Disagree/ Strongly disagree; Neutral is missing). R packages (especially package 'lme4') are used to execute this stage of the analysis.

- **Two-level models (students within universities)**

In this part of the multilevel generalized linear model for dichotomous outcome, the data are clustered in two levels, student (level-1) within university (level-2).

1) The simple generalized mixed effect model (intercept-only) is the null model that has no predictor variables (Finch et al. 2014). For university j, the formula of this model is:

$$\ln\left(\frac{p(y=1)}{1-p(y=1)}\right) = \beta_j \qquad (3.3)$$

The model expresses the natural logarithm of the ratio between $p(y = 1)$, the probability that a student in university j will give a response indicating satisfaction, and the probability that the opposite will happen, $p(y = 0)$. , β_j is the intercept.

Allowing the intercept to differ across universities (clusters) leads to the random intercept that we can express as:

$$\beta_j = \gamma + u_j$$

In this form, γ represents an average intercept value that holds across clusters and it is called a 'fixed effect' because it remains constant across all clusters, u_j is a group-specific effect on the intercept and it is called a 'random effect' because it varies from cluster to cluster. When the two components of the random intercept are substituted into the model (3.3), the generalized linear mixed effect model (3.4), sometimes called the null model, is obtained:

$$\ln\left(\frac{p(y=1)}{1-p(y=1)}\right) = \gamma + u_j \qquad (3.4)$$

The variance of the u_j's is denoted σ_j^2.

2) When the generalized linear mixed effect model is extended to include predictor variables at level-1, the model becomes:

$$\ln\left(\frac{p(y=1)}{1-p(y=1)}\right) = \gamma + u_j + \beta_1 x_{1ij} + \beta_2 x_{2ij} + \cdots + \beta_n x_{nij} \qquad (3.5)$$

$$u_j \sim N(0, \sigma_j^2)$$

Where x_{1ij} to x_{nij} are the independent variables (predictors). (e.g. gender, path in high school, level of study) and β_j is the slope of the relationship between the response and the

j'th independent variable (which does not vary from university to university). All variables used in this study are listed in *Table 3-4*.

- **Three-level models (students within colleges/department within universities)**

In this part of generalized multilevel modelling, the data are clustered within three levels, student (level-1) within college or department (level-2) within university (level-3).

1) The simple generalized mixed effect model (intercept-only) is expressed as:

$$\ln\left(\frac{p(y=1)}{1-p(y=1)}\right) = \gamma + u_k + u_{jk} \qquad (3.6)$$

$$u_k \sim N(0,\ \sigma_k^2) \qquad u_{jk} \sim N(0,\ \sigma_{jk}^2)$$

Where the jth level-2 cluster (college or department) in the kth level-3 cluster (university), u_k and u_{jk} are the random intercepts for level-3 and level-2, respectively,. There are now two parameters, $\sigma_k^2$and σ_{jk}^2 ,which describe the variation between universities, between colleges or department from the same university.

2) The generalized mixed effect model with predictor variables at level-1 is expressed as:

$$\ln\left(\frac{p(y=1)}{1-p(y=1)}\right) = \gamma + u_k + u_{jk} + \beta_1 x_{1ijk} + \beta_2 x_{2ijk} + \cdots + \beta_n x_{nijk} \quad (3.7)$$

Where x_{1ijk} to x_{nijk} are the predictors and β_k is the slope of the relationship between the response and the k'th independent variable (which does not vary from university to university).

Akaike and Bayesian Information Criterion (AIC) & (BIC): These are used as criteria for model selection (Demyanov, Bailey, Ramamohanarao & Leckie 2012). The formula of AIC and BIC are:

$$AIC = -2\log(Likelihood) + 2k$$

$$BIC = -2\log(Likelihood) + \log(N)\,k$$

Where k is the number of parameters estimated, N is the number of observations. AIC and BIC are based on the maximum likelihood estimates of the model parameters. To fit and compare models, the model with the smaller value of AIC and BIC is considered to be better. AIC and BIC offer a relative estimate of missing information when a given model is used to represent the process of generating data, where the good model minimises the loss of information. Mazerolle (2006) proposed that *"The AIC penalizes for the addition of parameters, and thus selects a model that fits well but has a minimum number of parameters (i.e., the principle of simplicity and parsimony),"* (p. 171). Since BIC has a larger penalty term, it tends to favour simpler models than AIC.

Predictor variables: While the simple models explain some variation just by institutional factors (one institution is different from another), there are variables whose effect must be examined at the level of individual students. In this study there are eight explanatory variables which follow:

1. **Study_level:** The completion of undergraduate study in Saudi Arabia requires four years. (A foundation year, which is a requirement in some colleges, is not included.) Each year consists of two semesters, making the duration of study eight semesters.
2. **Stat_level:** Level of study when studying statistics. The timing of teaching statistics courses differs from one college to another during the eight semesters that a student typically spends in higher education in Saudi Arabia, according to the plan of study at that college. Therefore, it might be important to know at what level participants studied statistics courses. The relevant question (Question 7) is a multiple choice question, as it depends on the number of statistics courses completed by each student. The most recent statistics course studied by the student was identified from their response and used to create seven indicator variables, one each for the course being in or not in Semesters 1, 2, …, 7. (Studying statistics in Semester 8 was used as a baseline for the models.)
3. **English_Language_Ability:** The ability of participants in English Language.
4. **Hours:** The numbers of hours spent studying statistics outside of lectures, on a weekly basis, on their own or with friends, were categorized into three periods: less than an hour, one to two hours and three hours or more.
5. **Sex:** The gender of students.
6. **High_school:** Scientific, Humanity and Management paths are available for students when they enter high school.

7. **Stat_course:** the numbers of statistics courses participants have completed.
8. **Language:** Two main languages are used in institutions of higher education in Saudi Arabia, Arabic and English.
9. **Using statistical programs:** Students have or have not used any statistical software programs during their statistical courses.

All these variables are added to the full model at student level. *Table 3-4* summarise these variables.

Table 3-4 The Explanatory Variables

Variable	Description
Stat_level	At what level participants studied statistics courses
English_Language_Ability	The ability of participants in English Language
Hours	The numbers of hours weekly, spent on course by participants
Sex	The gender of students
High_school	The path through high school that each student took
Stat_course	How many statistics courses participants have completed
Study_level	The current level of study of participants at the time of participation
Language	The main language used in teaching statistics courses
Statistics programs	Using statistical software programs during their statistical courses

Fitting models: In this part of the analysis, the multilevel model is used in three phases. Firstly, fit two-level models (student within university); secondly, fit three-level models (student within college, within university); finally, fit three-level models (student within department, within university) where the structure of the data set indicates they need these levels. In each phase, the multilevel model starts with a simple model of factor without explanatory variables (intercept-only). After that, the model is improved upon by examining the effect of predictor variables at the student level; thus, the multilevel model starts with a full model (random intercept). Backward elimination is an approach used in fitting models to select the final model. AIC and BIC provide the criteria to choose the best model of the six models. The procedure is as follows;

- Step 1: Start with all the predictor variables (*Table 3-4*) in the model.
- Step 2: Identify the predictor variable with the lowest AIC and BIC value, then omit that variable from the model.
- Step 3: Refit the model and apply step 2 again.
- Step 4: Continue until there is no further improvement when a variable is omitted from the model.

At the end, each factor will have six models (two models for each phase) and these will be compared to one another to ensure that the model selected is the most appropriate model for those factors.

3.10. Ethical issues

Ethical issues are a vital consideration when conducting a study of any nature. It is important to ensure that the research does not include threats against, or raise sensitive matters for, respondents (Cohen et al. 2013). The ethics committee is considered an important quality assurance body in institutions; this committee approves proposals, ensuring that there is nothing harmful within the study and that its setting is appropriate for the purpose of the research (Bell 2005). Consequently, the research proposal, questionnaire and interview questions were examined by the College of Science and Engineering Ethics Committee at the University of Glasgow. They gave permission to conduct the research. Also, since the study was conducted in Saudi Arabia, the proposal was agreed with the Royal Embassy of Saudi Arabia (Cultural Bureau in London) and the researcher's sponsor, Al-Imam Mohammed bin Saud University.

3.11. Summary

This chapter has described the research design and instruments (including their translation). Also, it has covered information about the pilot study. It has discussed the data collection processes and how the participants were invited to participate in the study. Lastly, it clarified the techniques that were used in data analysis.

Briefly: a mixed methods approach is used in this study. The participants included 1053 non-specialist students, both male and female. Sixteen teachers of statistics who teach non-specialist students were included in the qualitative interview phase. Factor analysis and multilevel modelling are used to analyse the questionnaire data whilst an inductive thematic approach was taken to the qualitative data gathered. The next chapter will discuss the results and analysis of this study.

Chapter 4. Results of Student Questionnaires

4.1. Introduction

The main aim of the study was to investigate the current state of teaching and learning statistics for non-specialist students in Saudi universities. This chapter presents results from the first phase, students' questionnaire data, which were obtained from non-specialist students who had completed at least one course in statistics. This chapter details demographic information about the participants and the results of the data analysis.

4.2. Descriptive statistics

4.2.1. Demographic information about participants

Gender: As described in chapter 3, the total number of survey respondents is n=1053. The participants included 855 male students (81%) and 198 female students (19%). *Table 4-1* summarises the demographic information about participants in this study.

High school path: Scientific, Humanity and Management paths are available for students when they enter high school. Participants in this study are distributed on these paths as follows. The majority of participants (n=831), which is 79% of the total participants, followed the scientific path. 172 (16%) of participants followed the humanities path and 50 (5%) the management path (*Table 4-1*).

Level of study: *Table 4-1* presents each participant's level of study at the time of participation. The largest numbers (25%) of participants are studying at semester seven (*Table 4-1*), while fewer of them (6%) are studying in the first year (semesters 1 and 2).

Level of study when studying statistics: *Table 4-1* indicates that 59% of participants studied a statistics course during first year (level 1 and 2).

Number of statistics courses: 833 participants (79%) completed one course in statistics, 191 participants (18%) completed two courses and only 29 students (3%) studied three courses or more (*Table 4-1*).

Hours of study: Descriptive statistics indicated that the largest number of students (n = 438, 42%) had been spending one to two hours weekly in studying statistics, followed by those who had been spending less than one hour (n=364, 35%) and finally, those who had spent three hours or more (n = 251, 24%) (*Table 4-1*).

Language of course: 564 participants, which is 54%, claimed they were taught the statistics courses in the Arabic language, while 46% (n = 489) claimed to be taught in the English language (*Table 4-1*). However, some students seemed confused about how to answer this question since there was disagreement in the same class about whether the course was taught in English or in Arabic. The researcher came to realise that some students think, if English symbols have been used within a course taught in Arabic, that the course was taught in English.

Table 4-1 The Demographic Information on Participants

	Frequency	Percent
Gender		
Male	855	81%
Female	198	19%
Path of High School		
Scientific	831	79%
Humanity	172	16%
Management	50	5%
Level of study		
Level1	3	0%
Level 2	63	6%
Level 3	173	16%
Level 4	136	13%
Level 5	175	17%
Level 6	96	9%
Level 7	260	25%
Level 8	147	14%
The Level of Study when Studying Statistics		
Study statistics at Level 1	295	28%
Study statistics at Level 2	325	31%
Study statistics at Level 3	227	22%
Study statistics at Level 4	165	16%
Study statistics at Level 5	171	16%
Study statistics at Level 6	79	8%
Study statistics at Level 7	31	3%
Study statistics at Level 8	0	0%
Number of Statistics courses		
One course	833	79%
Two courses	191	18%
Three or more	29	3%
Hours of studying		
Less than an hour	364	35%
One to two hours	438	42%
Three hours or more	251	24%
Language of course		

Arabic	564	54%
English	489	46%

English Language Ability: In this part of the survey, students are asked to evaluate themselves in four English language skills (reading, writing, speaking and listening), according to three ability levels: Excellent (scored 1), Good (scored 2) and Poor (scored 3). Within the reading skill (*Table 4-2*), few participants (9%) claimed to have a poor level. The largest number of respondents, 49% and 47%, classified themselves in the good level within writing and speaking skills, respectively. Finally, only 16% of participants evaluated themselves at a poor level of listening skill. Cross-tabulations and chi-square tests were conducted to identify the level of association between these skills. The associations were very strong and the chi-square tests gave highly significant results, so the mean value of the four scores was calculated to give an overall score for English language skill on a scale from 1 to 3 where 3 represents the poorest level of ability.

However, variations in English language ability existed amongst participants, based on their distribution at colleges and universities (*Figure 4-1* & *Figure 4-2*). Participants in King Fahd University, Prince Mohammed University and Jubail Industrial College, where English is used as the main language, evaluated themselves with high ability levels in English. However, participants in Dammam, King Faisal and Al-Imam (Al-Hassa branch) universities, where English is used as the main language only in some colleges, had more disparate evaluations of their English language ability (*Figure 4-1*).

Table 4-2 English Language Abilities of Participants

	Reading		**Writing**		**Speaking**		**Listening**	
Excellent	475	45%	315	30%	276	26%	464	44%
Good	480	46%	517	49%	496	47%	417	40%
Poor	98	9%	221	21%	281	27%	172	16%

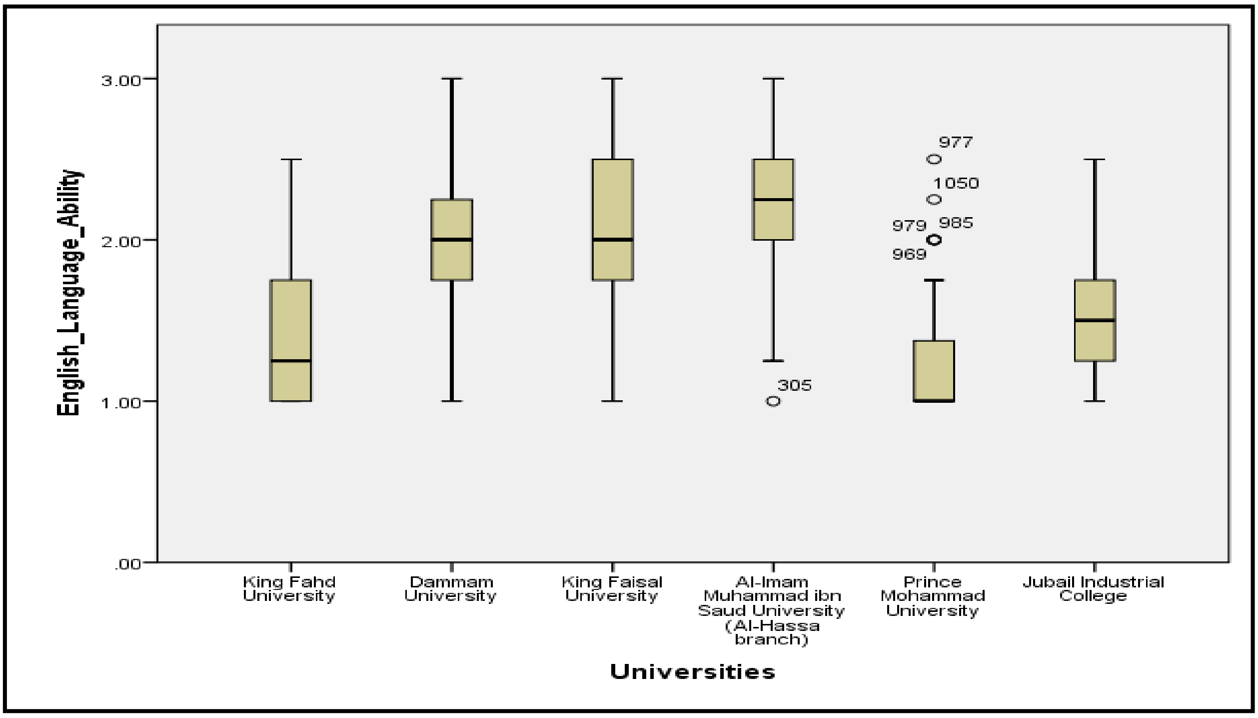

Figure 4-1 English Language Ability of Participants in Universities

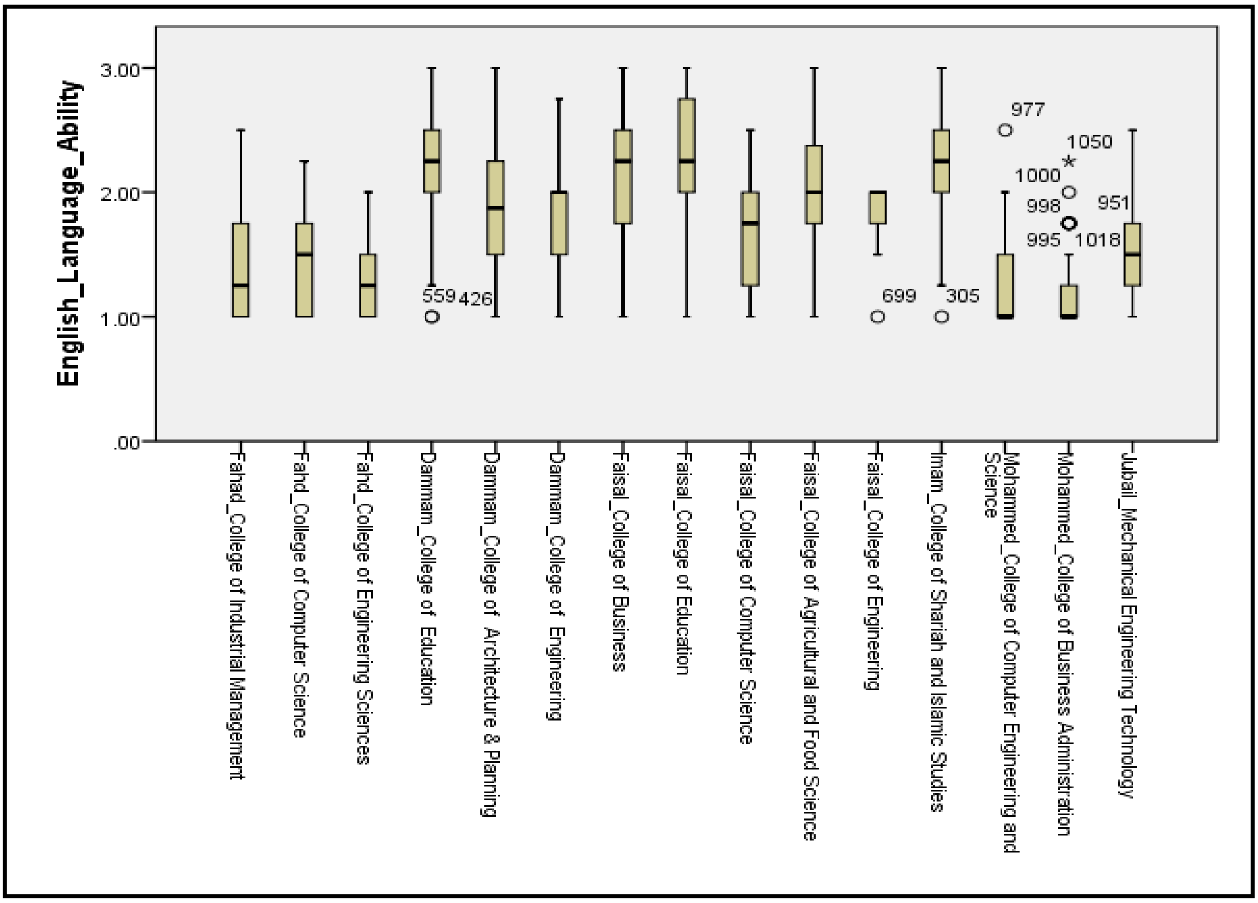

Figure 4-2 English Language Ability of Participants in Colleges

4.2.2. Participants' responses to the scale items

The researcher used this part of the survey to address Research Question one. The scale items consisted of 22 items and measured how statistics courses are taught currently to non-specialist students in Saudi universities on a 5-point Likert scale (1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree) with the additional option, 6 = Not Applicable (Appendix B). In this part of the questionnaire, non-specialist students were asked to rate their agreement toward each item. The 22 questions dealt with important issues which arise from literature in learning and teaching statistics, such as the benefit of statistics courses for other disciplines, teaching methods, teachers of statistics, and the use of technology and English language. Students' responses were coded for all items, so a higher score indicated a more positive satisfaction toward statistics courses and lower score indicated a more negative satisfaction. There were seven questions (19, 27, 28, 34, 35, 36 and 37) with negative direction, so they were reverse-coded.

Table 4-3 lists non-specialist students' responses for all questions. Non-specialist students indicated a range of satisfaction towards the most recent statistics course they had studied; namely: the knowledge of teachers, interactions between teachers with students and the teaching methods used (items 11, 15, 16, 17, 18 and 20); the relevance and importance of the statistics course, its criteria, resources and time availability (items 12, 13, 14 and 19).; using technology and its effect in learning and teaching statistics (items 26, 27, 28 and 29); the desire of students to study statistics (items 30, 31, 32 and 33) and finally the effect of their English language ability (items 34, 35, 36 and 37). Participants' responses to this part of the questionnaire indicated that non-specialist students' satisfaction is neutral overall, since the median for 16 of the individual questions is 3 (*Table 4-3*).

Among these questions, for example items 27, 28, 29, 35, 36 and 37 have a lot of people who selected the 'Not Applicable' option. It is noted that these questions are related to the use of technology and statistical software programs. Evidently, there are some students who have worked with teachers who simply do not use technology. Furthermore, some questions (e.g. 11, 15, 18 and 20) have a median of 4. They are very much skewed to the left (negative) because 4 or 5 are the high value. This could be the result of ceiling effects, so that if it were possible to write the questions in different way, then it may be possible to separate out the people who classify themselves in the top end. This is a possible challenge for future research. Similarly, for example questions 13 and 29 have median of 3 and results are mainly in the bottom end, while a lot of people are in 1 or 2 and few of them in 4 or 5, which could be due to floor effects. So, if we were able to rewrite some of these questions in a different way, then we may able to spread the responses out further. In addition, the responses to some of these questions are bimodal, especially Q26, and it is possible that this was caused by different patterns of responses being generated from students who have or who have not used statistical software. Therefore, one thing that I consider vital to any future study is to better investigate the structure of these responses; is there a systematic difference between students depending on their type of experience (e.g. the main language that is used or different universities that students attend)?

Table 4-3 Frequencies, Medians and Standard Deviation of Non-specialist Students' Responses to Items in the Questionnaire

	Scale Items	1	2	3	4	5	N/A	*M*
11	The teacher was knowledgeable about statistics.	28	26	93	431	472	3	4
12	The contents of the course were relevant to my main subject of study.	145	196	254	330	98	30	3
13	The examples which were used in the course were relevant to my main subject.	157	256	255	274	86	25	3
14	The importance of the course to my main subject was clarified at the beginning of the statistics course.	191	255	240	239	100	28	3
15	The criteria which were used to grade my course assessments were clarified at the beginning of the course.	52	68	102	465	358	8	4
16	The teaching methods used by the teacher helped me to learn effectively.	99	150	234	342	222	6	4
17	The teacher engaged the students using interactive exercises.	160	231	247	266	128	21	3
18	The teacher was receptive to students' questions.	40	51	126	406	426	4	4
19	I found it difficult to find good statistics resources and references that were relevant to my main subject.*	105	196	358	236	87	71	3
20	I was able to complete the work of the course in the time available.	68	121	236	430	171	27	4
26	The teacher used technology (e.g. Powerpoint, the internet, statistical packages) effectively to help teach this course.	214	122	83	264	241	129	4
27	Using a statistical software program led me to concentrate on the technology and not the statistical concepts being taught.*	57	190	233	140	212	221	3
28	Using a statistical software program to compute the statistical problems caused me misunderstanding of some steps of statistical procedures.*	57	160	210	236	143	247	3
29	Enough time was spent in learning and using a statistical software program.	189	202	208	177	47	230	3

30	I could have used technology to learn statistics just as effectively without the teacher.	169	194	236	248	77	129	3
31	I am enjoying studying statistics.	192	158	259	295	135	14	3
32	I will be able to apply the statistical concepts I learned from the course in my main subject.	143	155	310	317	101	27	3
33	I will be able to apply the statistical concepts I learned from the course in my future employment.	130	139	321	341	102	20	3
34	Some statistical technical words which are not translated into my language make it difficult for me to learn statistics.*	111	218	227	257	163	77	3
35	Most statistical software programs are in English and this make it difficult to learn statistics.*	86	180	203	215	198	171	3
36	My lack of English language skills is an obstacle to me using statistical software programs.*	119	203	166	240	188	137	3
37	My level of English language skills has prevented me from accessing statistics resources and references in the English language.*	130	194	177	242	194	116	3

*Reverse coded

4.2.3. Using Statistical Software Programmes

Another part of the questionnaire asked participants whether they had used statistical software programs during their studies, and what those programs were. The results, as presented in *Table 4-4*, indicate that 59% of participants (n = 626) have not used any kind of statistical program, while 41% (n = 427) of them have. Furthermore, *Table 4-4* shows the programs used and the number of students that had used each program; a few students had used more than one program.

Table 4-4 Frequencies of Students' Responses to Using Statistical Software Programs and which Programs are used

	Frequency	**Percent**
Have used any statistical software programme?		
Yes	427	41%
No	626	59%
Excel	305	29%
Minitab	67	6%
SPSS	65	6%
SAS	13	1%
R	1	1%
JMP	0	0%
Other	66	6%

4.2.4. Using Activities in Statistics Courses

This section is the last part of quantitative data in the questionnaire. Participants were asked about the kinds of activities that were completed as part of their statistics courses and how the participants did these activities. *Table 4-5* presents the summary of these activities. In apparent contradiction with responses to Q17, the most popular activities in the classroom were the solution of problems (n=714, 67%) and the use of discussion (n=729, 69%). Furthermore, homework was the activity most often completed in the student's own time (n=836, 79%). The activities that were completed as a group of students are close to each other.

Table 4-5 Frequencies of Responses to Activities that are Used

	With the lecturer		**With group of students**		**On my own**	
Solve statistical problems.	714	67.4%	433	41.1%	495	47%
Undertake project involving the use of statistical concept.	340	32.3%	331	31.4%	187	17.8%
Discussion and conversation.	729	69.2%	430	40.8%	53	5%
Data analysis using a computer.	317	30.1%	248	23.6%	328	31.1%
Homework.	71	6.7%	323	30.7%	836	79.4%

4.3. Exploratory Data Analysis

With the lack of existing information and data relevant to the current state of learning and teaching statistics to non-specialist students in Saudi universities, it is important to explore the data from this study in more detail. Exploratory data analysis techniques enable us to obtain a clear overview about the current situation of statistics learning and teaching to non-specialist students in different Saudi universities, which may not be found through other methods of analysis. Therefore, exploratory data analysis can contribute valuable insights that help in describing how statistics courses are currently taught in Saudi universities.

There is only room to include in this thesis a selection of the many tables for descriptive and exploratory data analysis that I produced, so I have selected the most important tables by following a specific strategy. After the frequencies of students' responses is presented (*Table 4-3*), all questions were grouped based on the important issues identified in the literature review, in order to deal with the key pointes related to these questions. Five groups were obtained and I will focus in particular in the following sections on the group of questions of English Language and the group of Technology, where these present the main issues examined within this study, so I will spend time discussing those factors in greater detail. Then, chi-squired tests were used to determine the significance of the association between questions and predictor variables. Also, Cramers’ V is used to define the strength of the associations. Ten predictor variables have been selected based on their importance and their potential impact on students’ responses. The ten predictor variables are 1) Universities, 2) Colleges, 3) Main language used in teaching statistics courses, 4) Gender of students, 5) Using statistical software programs, 6) Path through high school, 7) Number of statistics courses studied, 8) Numbers of hours of studying, 9) Participants' current level of study, 10) Students' English language ability.

As I mentioned early in chapter 3, there is a limitation to the number of female participants in this study; female students came from just two universities, while the male students were from all six universities, so the comparison between questions and the gender variable (variable 4) was restricted only to males and females from the same universities (King Fisal and Prince Mohammed universities), where universities and colleges can have substantial influence on results. However, when chi-squared tests were conducted between all groups of questions and the gender of students’ variable, including all universities, there was no difference in the significance of the associations before and after the gender restriction. Furthermore, it is important to look at the effect of English language ability (variable 10) on students’ responses. However, the variable is continuous, comprising the mean value of the four English language skills on a scale from 1 to 3 where 3 represent the poorest level of ability on the discreet variables (questions). So, one effective way to relate this variable to the other discrete variables is discretizing the continuous variable (English language ability) to three categories which are 1, 2 and 3.

On the other hand, the variable for the statistics level of study was measured using multiple choice, divided into seven indicator variables (see the section of predictor variables in chapter 3). Chi-squared tests of the seven variables were conducted with all questions. There is no significant association between them and the results do not give us important information, so the predictor variable (statistics level of study) is eliminated from the rest of the study.

The Bonferroni correction is a method used to address the problem of multiple comparisons. The correction is based on the idea that if n independent hypotheses on a set of data are being tested, then one way of maintaining the familywise error rate is to test each individual hypothesis at a statistical significance level of $1/n$ times what it would be if only one hypothesis were tested. So, if a researcher wants the significance level for the whole family of tests to be α, then the Bonferroni correction could be used to test each of the individual tests at a significance level of α/*n*. In this study, with 10 tests and ∝= 0:05, I would only reject a null hypothesis if the p-value is less than 0.005. However, many chi-squared tests have warning messages about cells that have expected counts less than 5, so to eliminate this problem I have combined neighbouring columns (1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree), depending on the pattern of expected frequencies. Nevertheless, in some cases this does not solve the problem, so I have combined rows that have the same natural groupings (e.g. small colleges in the same university).

It is worth mentioning that the objective here is not to explore the results question by question, but to look at where the pattern is, to determine the most important aspect. Therefore, if all questions of specific groups have a similar relationship with one predictor variable, only the question which is more interesting to that variable will be described in detail, rather than all of them. Cross-tabulation and bar charts were used to present the results. If the association between question and variable is significant, and has an obvious trend, a bar chart is used to show the relationship more clearly. However, a bar chart is undesirable with variables that have many groups (e.g. universities and colleges), where the data would be unclear even if the association was significant, so cross-tabulation is used. Further, if the association between questions and variables is not significant, cross-tabulation was used to present the relationship in number of frequencies.

4.3.1. English Language:

This group consists of several questions, including 34, 35, 36 and 37. Based on the literature, I developed these particular questions to investigate issues surrounding the use of English language in statistical resources. Therefore, I took these questions and put them together to try to explore the whole issue of English language. The Chi-square test is used as a guidance tool to select the most important tables for exploratory data analysis. *Table 4-6* shows the significance of associations (p-value) and the strength of the association (Cramer's V) between all questions of this group and predictor variables. It is important to note that, though many of the tests are highly significant, the Cramer's V statistics are generally rather small indicating that the associations are rather weak.

There are several chi-squared tests with an expected count less than 5, where the numbers of students in those cells are very small. Therefore, in some cases, neighbouring columns, rows or both have been combined, depending on the pattern of expected frequencies. Details about these combinations will be given in the following predictor variable sections. Furthermore, all the questions of this group demonstrated a negative direction, so they were reverse-coded, which means that option number 5 refers to the positive experience among students and they do not have difficulties with English issues.

Table 4-6 Chi-square test for Group of English Language items versus Predictor Variables

		Uni	Colleges	Main language	Sex	Statistics programs	High school	Stat courses	Hours	Study level	English ability
reQ34	p-value	.001	.010*	.044	.006	.005	.025	.372*	.072	.630*	.000
	C.V	.109	.141	.100	.171	.123	.095	.066	.086	.058	.185
reQ35	p-value	.000	.000*	.000	.310	.000	.000*	.684*	.940	.144*	.000
	C.V	.174	.221	.228	.103	.189	.164	.051	.041	.080	.240
reQ36	p-value	.000	.000*	.000	.146	.000	.000	.112*	.780	.008*	.000
	C.V	.204	.272	.317	.120	.207	.158	.090	.051	.099	.372
reQ37	p-value	.000	.000*	.000	.229	.000	.000	.004*	.128	.000*	.000
	C.V	.207	.243	.338	.108	.193	.169	.127	.082	.118	.363

*cells have had to be grouped to eliminate all expected frequencies less than 5 (see text for more details).

University: There are significant relationships between students' responses for all questions within this group and universities they have attended, so in this section, only the responses of question 36 will be presented, where it illustrates the difficulties of lack of English language skills on using statistics programs. *Table 4-7* compares the distribution of the question 36 scores, depending on the six different universities that students have attended. Within King Fahd, Prince Mohammad and Jubail universities, all of which use English as the main language for teaching, 74%, 59% and 50% of students, respectively, are satisfied with their English language skills (scores of 4 or 5) and they did not find difficulties with using statistical software programs. It is perhaps surprising that in Jubail College, although English is the main language of instruction, about 33% of students were dissatisfied with their English skills and felt less able to use statistical software programs in their studies. After that came the other universities, where some of the colleges used English and the others used Arabic; a higher proportion of students in these universities have had greater difficulties with English skills in using statistical software programs. However, the influence of universities is expected, where universities determine programme selection criteria - so they will select students for their ability overall, which may include English language ability.

Table 4-7 Cross-tabulation reQ36 versus universities

		Recode_ Lack of English language skills is an obstacle to using statistical software programs					Total
		1	2	3	4	5	
Universities	King Fahd University	5 3.3%	15 9.9%	19 12.5%	37 24.3%	76 50.0%	152 100.0%
	Prince Mohammad University	7 6.5%	19 17.8%	17 15.9%	36 33.6%	28 26.2%	107 100.0%
	Jubail Industrial College	7 9.3%	18 24.0%	12 16.0%	25 33.3%	13 17.3%	75 100.0%
	Dammam University	15 11.7%	37 28.9%	25 19.5%	31 24.2%	20 15.6%	128 100.0%
	King Faisal University	61 16.6%	87 23.6%	78 21.2%	96 26.1%	46 12.5%	368 100.0%
	Al-Imam Muhammad ibn Saud University	24 27.9%	27 31.4%	15 17.4%	15 17.4%	5 5.8%	86 100.0%
Total		119 13.0%	203 22.2%	166 18.1%	240 26.2%	188 20.5%	916 100.0%

College: The relationship of all questions within this group and the colleges students have attended are significant except for question 34. Perhaps, therefore, this question refers to the influence of translating the technical words on the understanding of statistical aspects, unlike other questions which refer to the influence of English on the use of software programs and accessing statistics resources. All chi-squared tests of this variable have an expected count less than 5 (*Table 4-6*) because columns (1 and 2) and rows (Engineering and computer science colleges in King Fisal University) have a small number of students, so they were combined to eliminate the problem. *Table 4-8* compares the distribution of question 37 for students who were attending different colleges. The question shows the importance of English skills and their impact on students' access to statistics resources in different colleges, where the availability of these resources in Arabic is rare compared to those in English. The majority of students who studied in science colleges (e.g. computer science, engineering) were more satisfied with their English skills in terms of accessing resources. However, most students who studied in other colleges (e.g. education, agricultural, and Islamic studies) had a negative experience of the impact of English on accessing resources.

Table 4-8 Crosse-tabulation reQ37 versus colleges

		Recode_English language skills have prevented students from accessing statistics resources in the English language					Total
		1	2	3	4	5	
Colleges	Fahd_College of Engineering Sciences	0 0.0%	5 9.1%	6 10.9%	14 25.5%	30 54.5%	55 100.0%
	Fahad_College of Industrial Management	1 1.8%	8 14.5%	6 10.9%	15 27.3%	25 45.5%	55 100.0%
	Faisal_College of Computer Science	5 6.5%	10 13.0%	11 14.3%	32 41.6%	19 24.7%	77 100.0%
	Mohammed_College of Computer Engineering and Science	1 4.5%	3 13.6%	4 18.2%	8 36.4%	6 27.3%	22 100.0%
	Fahd_College of Computer Science	1 2.3%	7 16.3%	8 18.6%	7 16.3%	20 46.5%	43 100.0%
	Faisal_College of Engineering	2 15.4%	1 7.7%	2 15.4%	5 38.5%	3 23.1%	13 100.0%
	Mohammed_College of Business Administration	7 8.1%	16 18.6%	14 16.3%	30 34.9%	19 22.1%	86 100.0%
	Jubail_Mechanical Engineering Technology	4 4.5%	12 13.5%	23 25.8%	31 34.8%	19 21.3%	89 100.0%
	Dammam_College of Architecture & Planning	11 25.6%	5 11.6%	6 14.0%	11 25.6%	10 23.3%	43 100.0%
	Dammam_College of Engineering	4 9.8%	13 31.7%	8 19.5%	8 19.5%	8 19.5%	41 100.0%
	Dammam_College of Education	5 10.4%	14 29.2%	13 27.1%	10 20.8%	6 12.5%	48 100.0%
	Faisal_College of Agricultural and Food Science	14 20.3%	20 29.0%	14 20.3%	15 21.7%	6 8.7%	69 100.0%
	Faisal_College of Education	24 21.6%	31 27.9%	23 20.7%	25 22.5%	8 7.2%	111 100.0%
	Faisal_College of Business	27 25.7%	24 22.9%	25 23.8%	17 16.2%	12 11.4%	105 100.0%
	Imam_College of Shariah and Islamic Studies	24 30.0%	25 31.2%	14 17.5%	14 17.5%	3 3.8%	80 100.0%
Total		130 13.9%	194 20.7%	177 18.9%	242 25.8%	194 20.7%	937 100.0%

Language of course: All the questions in the group of English language questions have a significant association with the main language of the course, except question 34. This is possibly because the ability to use technical words is not affected by the main language of the course, as is the case with technology. *Figure 4-3* compares the distribution of question 35 scores for students who were taught statistics in Arabic and English. This question illustrates how the statistics software programs, which are in English, might cause some difficulties in learning statistics for students whose first language is not English. When English was the main language of the course, 20% of students had negative experiences with the use of software (scores of 1 or 2) and 55% of them expressed positive satisfaction (scores of 4 or 5). Of students who studied the statistics course in Arabic, 38% were dissatisfied and 36% positively satisfied. The results are not surprising: students who use English as the main language in studying a statistics course are not likely to report difficulties with using statistics software in learning statistics.

High school path: *Figure 4-4* compares the distribution of question 37 scores for students who came from different study pathways of high school. This question aims to establish whether or not students' access to statistics resources, based on their English ability, could be affected by the path they took through high school. Among students whose came from the scientific path, 30% had negative responses (scores of 1 or 2) regarding the effect of English skills in access to statistics resources in the English language, compared to 51% who had a positive response (scores of 4 or 5). On the other hand, 49% and 53% of students whose high school paths were humanities and management based, respectively, were not satisfied and just 28% and 16% were positively satisfied. It is perhaps surprising that in the humanities and management, although the same courses of English are taught in all paths of high school in Saudi Arabia, a high percentage of students had difficulties with accessing statistics resources because of their lack of English language ability. This may indicate that the academic level of students from the scientific path is better than those from the other paths. On the other hand, only the association of this question is presented, where the other questions have similar results, except question 34, where there is no significant association. Moreover, the chi-squared tests of this predicted variable with question 35 has an expected count of less than 5, so rows of the humanities and management paths of high school which have a small number of students were combined to eliminate this problem.

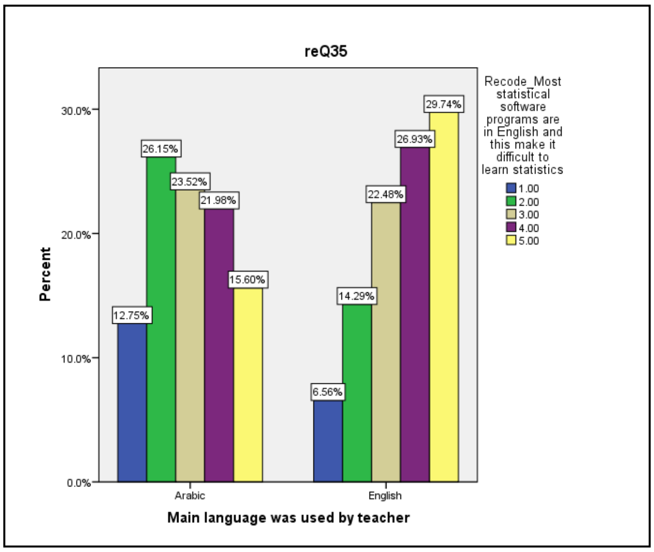

Figure 4-3 Bar chart reQ35versus Main Language of Course

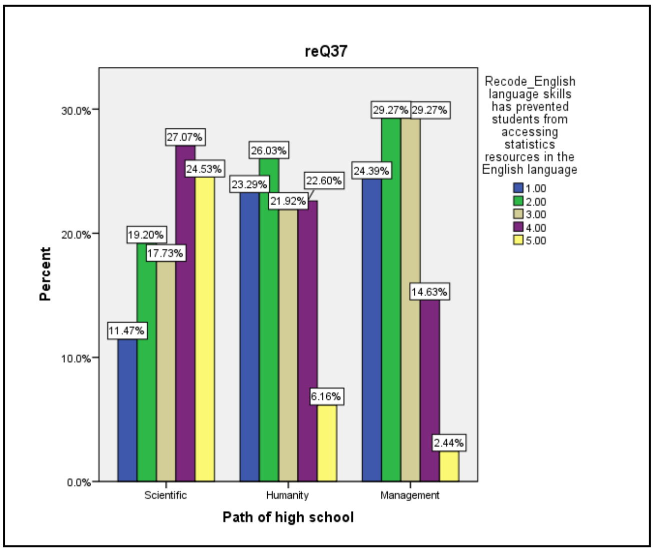

Figure 4-4 Bar chart reQ37 versus Path of High School

Using Statistical Software Programs: I have chosen to present the results of Question 36 in more detail. This question illustrates the difficulties arising from using English based statistical software programs, based on students' experiences of using these programs. *Figure 4-5* compares the distribution of question 36 scores for students who have or have not used statistical software programs. When students have used statistical software programs (Yes), 28% of students had difficulties with English language skills in using these programs (scores of 1 or 2) and 56% of them expressed positive satisfaction (scores of 4 or 5). Of students who have not used any statistical software programs (No), 40% were dissatisfied with their English language skills and 38% positively satisfied. All the questions of group 1 have the same results of association with the using statistical software programs variable, so only this question is presented.

Hours of study: There is no association between any questions of group 1 (English language) and the number of hours that students have spent in learning statistics. For example, *Table 4-9* shows there are no clear differences between the distributions of students' responses about the difficulties of technical words in learning statistics (question 34) within the three groups of the number of hours that have been spent in learning statistics. The percentages of students who had difficulties with technical words (scores of 1 or 2) remained close between the three groups. This is an expected result, because the difficulties of technical words that students have faced relies on their English skills ability, while the hours of study were spent in learning statistics itself, rather than improving these language abilities.

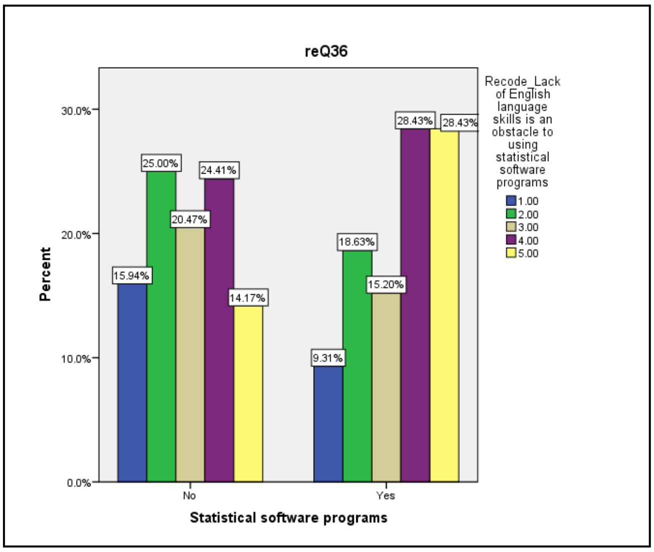

Figure 4-5 Bar chart reQ36 versus Using Statistical Software Programs

Table 4-9 Cross-tabulation reQ34 versus Hours of study

		Recode_Technical words which are not translated into their language make it difficult to learn statistics					Total
		1	2	3	4	5	
How many hours weekly have student spent studying statistics course	Less than an hour	36 10.9%	82 24.8%	84 25.4%	78 23.6%	51 15.4%	331 100.0%
	One to two hours	48 11.6%	97 23.4%	100 24.2%	106 25.6%	63 15.2%	414 100.0%
	Three hours or more	27 11.7%	39 16.9%	43 18.6%	73 31.6%	49 21.2%	231 100.0%
Total		111 11.4%	218 22.3%	227 23.3%	257 26.3%	163 16.7%	976 100.0%

Number of statistics courses: Only one question (reQ37) has a significant association with the number of statistics courses that students have completed. Furthermore, all chi-squared tests of this variable have an expected count of less than 5, so the two rows of two courses and three courses or more were combined to eliminate this problem. *Table 4-10* compares the distribution of question 37 scores for students who have completed different numbers of statistics courses. By excluding the group of students who have completed three courses or more, where the number of students is very small compared to the other two groups, all students' responses are almost the same. Within the group of students who have completed one statistics course, almost 31% (scores of 1 or 2) found that their English language skills caused difficulties for them when accessing statistics resources in English, while 19% were neutral and 48% (scores of 4 or 5) of them had a positive experience. On the other hand, of students who completed two courses, 39% (scores of 1 or 2) of students found that English skills negatively affected accessing statistics resources, where 40% (scores of 4 or 5) of them were satisfied. However, the results could indicate that accessing resources for non-specialist students may not very important, because the need for resources is limited, as the topics of statistics courses are basic.

Table 4-10 Crosse-tabulation reQ37 versus Number of statistics courses

		Recode_English language skills has prevented students from accessing statistics resources in the English language					Total
		1	2	3	4	5	
Number of statistics courses	**One course**	88 11.8%	153 20.5%	145 19.4%	203 27.2%	158 21.2%	747 100.0%
	Two courses	32 19.0%	35 20.8%	32 19.0%	35 20.8%	34 20.2%	168 100.0%
	Three or more	10 45.5%	6 27.3%	0 0.0%	4 18.2%	2 9.1%	22 100.0%
Total		130 13.9%	194 20.7%	177 18.9%	242 25.8%	194 20.7%	937 100.0%

Gender: Bearing in mind the limitations of only having data from female students at two of the universities under study, there is no significant association between any of the questions regarding the questions of group 1 and the gender of students. For example, *Table 4-11* compares the distribution of question 34 scores for male and female students where the question has the lowest p-value. Within male students, almost 38% (scores of 1 or 2) found that technical words which are not translated into Arabic language cause some difficulties in learning statistics, while 25% were neutral and 36% (scores of 4 or 5) of them had a positive experience. Of female students, 27% (scores of 1 or 2) found that technical words negatively affected on their learning statistics, while 21% were neutral and 50% (scores of 4 or 5) of them had a positive experience.

Table 4-11 Cross-tabulation reQ34 versus Sex of Respondents

		Recode_Technical words which are not translated into their language make it difficult to learn statistics					Total
		1	2	3	4	5	
Sex of respondents	**Male**	43 13.7%	78 24.8%	80 25.4%	79 25.1%	35 11.1%	315 100.0%
	Female	10 5.6%	40 22.3%	38 21.2%	59 33.0%	32 17.9%	179 100.0%
	Total	53 10.7%	118 23.9%	118 23.9%	138 27.9%	67 13.6%	494 100.0%

Level of study: This variable consists of eight levels (eight semester), and all chi-squared tests of this variable have an expected count of less than 5, so rows of each two semesters per year (e.g. 1 and 2) were combined to eliminate the problem. Also, for easier comparison, the distribution of students' responses within each year's level would be used instead of semesters. All group 1 (English language) questions have no significant association with this variable, except question 37. *Table 4-12* compares the distribution of question 37 scores for students who are studying in different levels (academic years) at the time of their participation in this study. There are some similarities in students' responses within the first and the last two years. Of students within Year 1 and 2, 29% and 23% of them were dissatisfied with their English language skills in accessing statistics resources in English (scores of 1 or 2), while students within Year 3 and 4 are 42% and 39% respectively. Of the students within Year 1 and 2, 53% and 54% (scores of 4 or 5) had positive experiences, while students with positive experiences within Year 3 and 4 are 40% and 42%. The similarity between students' responses within the first and last two years could perhaps be due to the convergence of students' academic levels and their experience. However, it is noted that the difference in the proportion of students' responses within different academic years is very small.

Table 4-12 Cross-tabulation reQ37 versus Students' Level of Study

		Recode_English language skills has prevented students from accessing statistics resources in the English language					Total
		1	2	3	4	5	
level of study	**Year 1**	3 5.2%	14 24.1%	10 17.2%	20 34.5%	11 19.0%	58 100.0%
	Year 2	18 6.3%	49 17.1%	62 21.7%	85 29.7%	72 25.2%	286 100.0%
	Year 3	50 20.7%	53 22.0%	41 17.0%	55 22.8%	42 17.4%	241 100.0%
	Year 4	59 16.8%	78 22.2%	64 18.2%	82 23.3%	69 19.6%	352 100.0%
Total		130 13.9%	194 20.7%	177 18.9%	242 25.8%	194 20.7%	937 100.0%

English language ability: This variable has a significant association with all the questions of this group. One interesting question is question 37, which illustrates the influence of the English language ability of students on their experience of accessing statistics resources. *Figure 4-6* compares the distribution of question 37 scores for students who have different English language abilities. Within participants who classified themselves in the third level (poor) of English language skills, 64% of students had a negative experience of the effect of English skills on their accessing statistics resources in English language (scores of 1 or 2), where 16% of them had positive experiences (scores of 4 or 5). However, participants who classified themselves in the first and second level (good and excellent) of English ability, 11% and 36%, respectively, were dissatisfied with their English skills in accessing statistics resources (scores of 1 or 2), while 77% and 40% of them, respectively, had a positive experience (scores of 4 or 5). These results are expected where students' accessing resources in English will be based on their English ability. The association between all the questions of this group and English language ability have similar results, so only this question is presented.

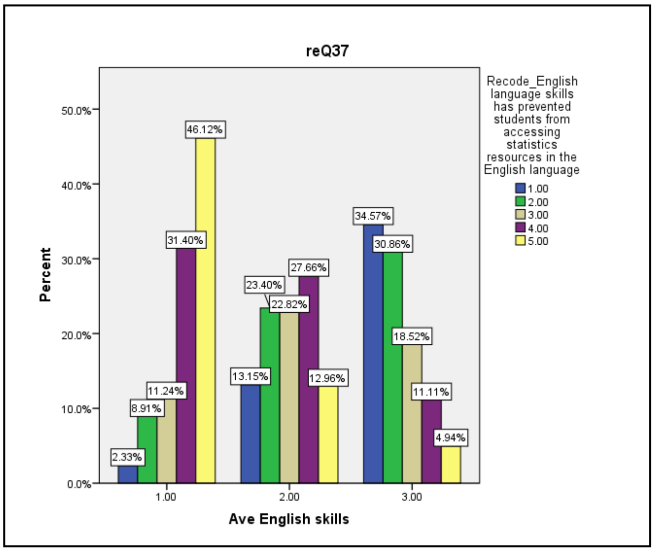

Figure 4-6 Bar chart reQ37 versus Students' English Language Ability

4.3.2. Using Technology:

Based on the literature, I put the questions of technology together to investigate issues about using technology in statistical resources in order to explore all the issues relating to using technology. This group consists of questions 26, 27, 28 and 29. *Table 4-13* shows the significance and the strengths of chi-square tests between all the questions for using technology group and predictor variables. Once again, several chi-squared tests have an expected count of less than 5, which are marked with stars, so in some cases neighbouring columns, rows or both have been combined, depending on the pattern of expected frequencies. Furthermore, questions 27 and 28 have a negative direction, so they were reverse-coded, which means that option number 5 refers to the positive experience among students and they do not have difficulties with technology issues. On the other hand, the responses to some of the questions are bimodal, especially Q26 (*Table 4-3*), and this may have been caused by different patterns of responses being generated from students who have and who have not previously used statistical software. 59% of participants have not used any statistical software programs *Table 4-4*.

Table 4-13 Chi-square test for Group of Technology items versus independent variables

		Uni	Colleges	Main language	Sex	Statistics programs	High school	Stat courses	Hours	Study level	English ability
Q26	p-value	.000	.000*	.000	.229	.000	.000*	.532*	.012	.704*	.000
	CV	.281	.440	.328	.108	.360	.187	.058	.103	.057	.176
reQ27	p-value	.000*	.000*	.000	.163	.000	.029*	.772*	.124	.462*	.000
	CV	.191	.277	.248	.123	.323	.114	.047	.087	.069	.142
reQ28	p-value	.000*	.000*	.001	.162	.000	.053*	.008*	.830	.317*	.036
	CV	.164	.216	.155	.125	.173	.108	.131	.052	.075	.101
Q29	p-value	.002*	.012*	.000	.199	.000	.675*	.951*	.490	.250*	.016
	CV	.120	.158	.179	.118	.185	.053	.029	.067	.078	.107

*cells have had to be grouped to eliminate all expected frequencies less than 5 (see text for more details).

University: There are significant relationships between students' responses for all questions of English language and the universities students have attended. In this section, only one interesting question (Q29) will be presented, where it illustrates whether or not the time that was spent in learning and using technology is sufficient. Some chi-squared tests of this variable have an expected count of less than 5, because columns (4 and 5) or (1 and 2) have a small number of students, so they were combined to eliminate this problem. *Table 4-14* compares the distribution of the question scores, depending on the six different universities that students have attended. In spite of 41% students having used statistical software programs in their studying of statistics, a high percentage of students in all universities (43%, 58%, 44%, 51%, 47% and 40%, respectively) were dissatisfied with the time that they have spent in learning and using technology (scores of 1 or 2). These results could be due to two main reasons: firstly, where the group of students who have not used the programs are interested to use the software in order to apply what they have learned in statistics; and secondly the group who have used the programs may have believed in the importance of these programs and want to further develop their skills. However, the influence of universities in technology issues is expected where the scheduled time for the use of technology, and policies about investment in technology, are often the responsibility of universities rather than colleges.

Table 4-14 Cross-tabulation Q29 versus universities

		Enough time was spent in learning and using a statistical software program					Total
		1	2	3	4	5	
Universities	King Fahd University	23 14.7%	46 29.5%	30 19.2%	46 29.5%	11 7.1%	156 100.0%
	Prince Mohammad University	19 17.3%	33 30.0%	23 20.9%	18 16.4%	17 15.5%	110 100.0%
	King Faisal University	76 24.0%	66 20.8%	94 29.7%	65 20.5%	16 5.0%	317 100.0%
	Jubail Industrial College	11 26.2%	6 14.3%	14 33.3%	11 26.2%	0 0.0%	42 100.0%
	Al-Imam Muhammad ibn Saud University	20 27.8%	17 23.6%	18 25.0%	17 23.6%	0 0.0%	72 100.0%
	Dammam University	40 31.7%	34 27.0%	29 23.0%	20 15.9%	3 2.4%	126 100.0%
Total		189 23.0%	202 24.5%	208 25.3%	177 21.5%	47 5.7%	823 100.0%

College: The relationship of all the questions of technology and the colleges that students have attended are significant, except in relation to question 29. Probably, those colleges have less impact on the scheduled time of learning technology (Q29) compared to the uses of software programs (Q26, Q27 and Q28). All chi-squared tests of this variable have an expected count of less than 5, because columns (4 and 5) and (2 and 3) have a small number of students, so they were combined to eliminate this problem. One question (Q26) that illustrates the effectiveness of using technology by teachers in different colleges, which has bimodal responses, is presented here. *Table 4-15* compares the distribution of this question for students who were attending different colleges. The impact of colleges on students' responses is clear, where the majority of students in some colleges (e.g. 91%, 87% and 85% for colleges within King Fahad University) were satisfied with the technology used by teachers; while in some other colleges the majority of students (e.g. 63% for Education college in King Faisal university and 74% for Shariah college in Imam university) were dissatisfied. Therefore, considering the colleges that students have attended, the bimodality of students' responses in question 26 disappears.

Table 4-15 Cross-tabulation Q26 versus Colleges

		Teacher used technology effectively					Total
		1	2	3	4	5	
Colleges	Fahad_College of Industrial Management	0 0.0%	0 0.0%	5 8.2%	25 41.0%	31 50.8%	61 100.0%
	Fahd_College of Computer Science	0 0.0%	2 4.1%	4 8.2%	26 53.1%	17 34.7%	49 100.0%
	Fahd_College of Engineering Sciences	3 5.5%	5 9.1%	0 0.0%	20 36.4%	27 49.1%	55 100.0%
	Dammam_College of Education	8 15.1%	5 9.4%	5 9.4%	20 37.7%	15 28.3%	53 100.0%
	Dammam_College of Architecture & Planning	12 26.7%	5 11.1%	10 22.2%	12 26.7%	6 13.3%	45 100.0%
	Dammam_College of Engineering	12 30.8%	12 30.8%	9 23.1%	2 5.1%	4 10.3%	39 100.0%
	Faisal_College of Business	26 24.1%	17 15.7%	13 12.0%	35 32.4%	17 15.7%	108 100.0%
	Faisal_College of Education	50 44.6%	22 19.6%	8 7.1%	16 14.3%	16 14.3%	112 100.0%
	Faisal_College of Computer Science	5 6.3%	5 6.3%	10 12.7%	27 34.2%	32 40.5%	79 100.0%
	Faisal_College of Agricultural and Food Science	16 27.1%	12 20.3%	3 5.1%	18 30.5%	10 16.9%	59 100.0%
	Faisal_College of Engineering	1 7.7%	0 0.0%	2 15.4%	4 30.8%	6 46.2%	13 100.0%
	Imam_College of Shariah and Islamic Studies	36 49.3%	18 24.7%	6 8.2%	6 8.2%	7 9.6%	73 100.0%
	Mohammed_College of Computer Engineering and Science	0 0.0%	0 0.0%	0 0.0%	11 47.8%	12 52.2%	23 100.0%
	Mohammed_College of Business Administration	1 1.1%	5 5.7%	5 5.7%	37 42.0%	40 45.5%	88 100.0%
	Jubail_Mechanical Engineering Technology	44 65.7%	14 20.9%	3 4.5%	5 7.5%	1 1.5%	67 100.0%
Total		214 23.2%	122 13.2%	83 9.0%	264 28.6%	241 26.1%	924 100.0%

Language of course: All the questions relating to technology have a significant association with the main language of the statistics course. One important issue is the influence of the main language on the time that is scheduled by institutions for learning software programs. Question 29 illustrates whether the time that students have spent in learning with technology is enough, or not. *Figure 4-8* compares the distribution of question 29 scores for students who were taught statistics in Arabic and English. When English was the main language of the course, 43% of students had negative experiences with the scheduled amount of time for technology allotted (scores of 1 or 2) and 32% of them were satisfied with their experiences (scores of 4 or 5). Of the students who studied the statistics course in Arabic, 50% were dissatisfied and 22% positively satisfied with their experiences. There is no big difference between the two groups, and that is not surprising where student satisfaction or dissatisfaction is not directly linked to the main language of the course, but rather is linked to the time determined by the institution (universities and colleges) for students to learn statistics using technology.

High school path: There are no significant associations between questions of technology and predictor variables, except for question 26 where this question explores whether or not students are satisfied with the technology used by their teachers. However, all the chi-squared tests of this predicted variable have an expected count of less than 5, so rows detailing the humanities and management paths of high school, which have a small number of students, were combined to eliminate this problem. *Figure 4-7* compares the distribution of question 26 scores for students who took different paths through high school. Among those students who came from the scientific path, 31% had negative responses (scores of 1 or 2) regarding technology used by their teachers, compared to 57% who had a positive response (scores of 4 or 5). On the other hand, 53% and 53%, respectively, of students whose high school paths were humanities and management based, respectively, were not satisfied, and 38% and 36% were positively satisfied. It is perhaps not surprising that students who came from the humanities and management paths have less experience with technology than students who came from the scientific path, so students from the humanities and management pathways must look to their teachers to use technology more effectively in order to introduce them to the use of technology in statistics.

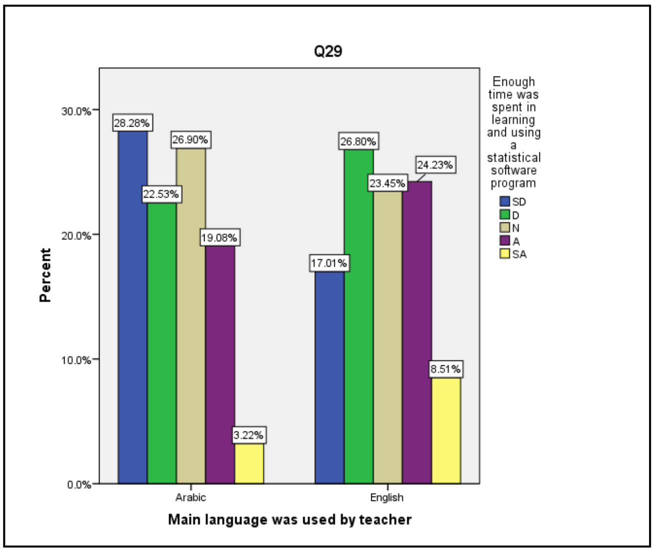

Figure 4-8 Bar chart Q29 versus Main Language of Course

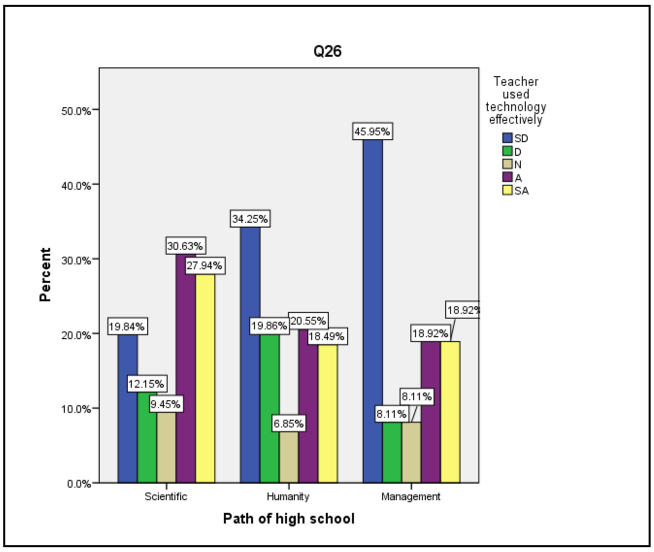

Figure 4-7 Bar chart Q26 versus Path of High School

Using Statistical Software Programs: All the questions in the technology group have a significant association with using statistical software programs, and they have the same results. Therefore, only question 27 is presented in more detail, where it illustrates the negative effect of statistics programs that may face students. *Figure 4-9* compares the distribution of question 27 scores for students who have used statistical software programs and those who have not. When students have used statistical software programs (Yes), 35% of students had no difficulties with using statistics programs and were able to concentrate on learning the statistics rather than spending too much time concentrating on technology itself (scores of 4 or 5), while 32% were neutral and 31% of them agreed they experienced difficulties that made them concentrate on the technology rather than the learning of statistics (scores of 1 or 2). Of students who have not used any statistical software programs (No), 60% had no difficulties with using statistics programs; 23% of students were neutral and 15% of them had difficulties with using the programs. Although the majority of students who have not used technology did not find difficulties, maybe this was partly due to their lack of experience with technology. This suggests they may not know what their particular difficulties are, or they may feel under-confident in using software programmes.

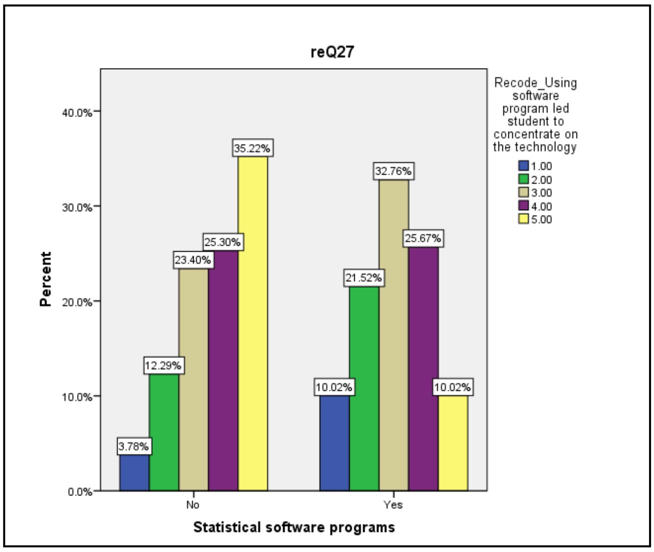

Figure 4-9 Bar chart reQ27 versus Using Statistical Software Programs

Hours of study: The same results obtained in questions related to English language were also found for questions of technology, in relation to hours of study; there is no association between all the questions of technology and the number of hours that students have spent in learning statistics. For example, *Table 4-16* shows that there are no differences between the distribution of students' responses and the time that students have spent in learning and using technology (question 29), within the three groups of the number of hours that students have spent in learning statistics. The percentages of students' responses remained close within the three groups. These results are expected where the time that students have spent in their learning of statistics may not include the time spent using technology, where it is scheduled by universities.

Table 4-16 Cross-tabulation Q29 versus Hours of study

		Enough time was spent in learning and using a statistical software program					Total
		1	2	3	4	5	
How many hours weekly have student spent studying statistics course	Less than an hour	72 25.8%	67 24.0%	73 26.2%	53 19.0%	14 5.0%	279 100.0%
	One to two hours	74 21.1%	83 23.7%	84 24.0%	89 25.4%	20 5.7%	350 100.0%
	Three hours or more	43 22.2%	52 26.8%	51 26.3%	35 18.0%	13 6.7%	194 100.0%
Total		189 23.0%	202 24.5%	208 25.3%	177 21.5%	47 5.7%	823 100.0%

Number of statistics courses: There is no significant relationship between this predictor variable and all the questions of technology. Furthermore, all chi-squared tests exploring the number of statistics courses variable have expected counts of less than 5, so the two rows options (two courses and three courses or more) were combined to eliminate this problem. For instance, *Table 4-17* compares the distribution of question 29 scores for students who have completed different numbers of statistics courses. All students' responses are almost the same within the three different groups. Therefore, the results could indicate that accessing resources may not be important for non-specialist students, because the need for these resources is very limited, as the topics of statistics courses are basic.

Table 4-17 Cross-tabulation Q29 versus Number of statistics courses

		Using software program led student to concentrate on the technology					Total
		1	2	3	4	5	
Number of statistics courses	One course	147 22.3%	171 25.9%	181 27.4%	115 17.4%	46 7.0%	660 100.0%
	two courses	38 24.7%	37 24.0%	46 29.9%	23 14.9%	10 6.5%	154 100.0%
	three or more	5 27.8%	4 22.2%	6 33.3%	2 11.1%	1 5.6%	18 100.0%
Total		190 22.8%	212 25.5%	233 28.0%	140 16.8%	57 6.9%	832 100.0%

Gender: Taking into account the limitation of female students only attending two of the universities where data was collected, there is no significant association between all the questions of technology and the gender of students. For example, *Table 4-18* compares the distribution of question 28 scores for male and female students, where the question has the lowest p-value. Students' responses about the misunderstandings in studying statistics that may be caused by using software programs are almost the same for male and female. male students, 48% (scores of 4 or 5) disagreed that misunderstandings in learning statistics were caused by software programs and they had positive experiences, while 21% were neutral and 29% (scores of 1 or 2) of them had negative experiences. Of female students, 38% (scores of 4 or 5) found that using software programs did not affect them in learning statistics, while 31% were neutral and 29% (scores of 1 or 2) of them found that some misunderstandings occurred through using software programs.

Table 4-18 Cross-tabulation reQ28 versus Sex of Respondents

		Recode_Using software program to compute problems caused misunderstanding of some steps of statistical procedures					Total
		1	2	3	4	5	
Sex of respondents	Male	21 7.9%	58 21.7%	58 21.7%	83 31.1%	47 17.6%	267 100.0%
	Female	12 7.9%	33 21.9%	48 31.8%	40 26.5%	18 11.9%	151 100.0%
Total		33 7.9%	91 21.8%	106 25.4%	123 29.4%	65 15.6%	418 100.0%

Level of study: The same conditions were applied to this variable as in group questions of English language, where all chi-squared tests of this variable have an expected count of less than 5, so the eight levels (two semesters per year) were combined to eliminate this problem. Also, for easier comparison, the distributions of students' responses within the year levels were used instead of semesters. Every question relating to technology has no significant association with this variable. For example, *Table 4-19* compares the distribution of question 27 scores for students who are studying at different levels (academic years). The similarities in students' responses are clear within the four academic years. For students within Year 1, 2, 3, and 4, 40%, 50%, 45%, and 48% of them, respectively, disagree that using software programs causes difficulties in studying statistics and they had positive experiences (scores of 4 or 5); further, students within Year 1, 2, 3, and 4, 27%, 22%, 24% and 22% of students, respectively, agreed and they had negative experiences (scores of 1 or 2). Therefore, we can conclude that the difficulties that may be caused by using software programs are not related to study level.

Table 4-19 Cross-tabulation reQ27 versus Students' Level of Study

		Recode_Using software program led student to concentrate on the technology					Total
		1	2	3	4	5	
Study_level	Year 1	0 0.0%	10 27.0%	12 32.4%	10 27.0%	5 13.5%	37 100.0%
	Year 2	19 8.0%	34 14.3%	65 27.4%	69 29.1%	50 21.1%	237 100.0%
	Year 3	16 7.0%	41 17.9%	65 28.4%	57 24.9%	50 21.8%	229 100.0%
	Year 4	22 6.7%	55 16.7%	91 27.7%	76 23.1%	85 25.8%	329 100.0%
Total		57 6.9%	140 16.8%	233 28.0%	212 25.5%	190 22.8%	832 100.0%

English language ability: This variable has a significant association with all the questions relating to technology. Also, the association between them has similar results, so only question 26 is presented here. One interesting question which has bimodal responses is question 26, where the influence of students' English ability on their opinions about the effectiveness of teachers' use of technology is illustrated. *Figure 4-10* compares the distribution of question 26 scores for students who have different English language abilities. Participants who classified themselves in the second and third levels (good and poor) of English language skills, 39% and 50% of students, respectively, had a negative experience of the effectiveness use of teachers' use of technology (scores of 1 or 2), where 50% and 40%, respectively, had positive experiences (scores of 4 or 5). Moreover, of those participants who classified themselves in the first level (excellent) of English ability, 21% were dissatisfied with the use of technology by their teachers (scores of 1 or 2), while 70% of them had a positive experience (scores of 4 or 5). However, the bimodality of responses remains consistent for the second and third groups (good and poor levels). We could speculate over the reasons for the two distinct groupings in our data (students have or have not used technology). This could be due to the way students' groups are clustered by institutions. Thus, a whole group of students shows a satisfaction with their teacher's use of technology, unlike another group. If the study was applied in different place, different clusters could result in another distribution shape.

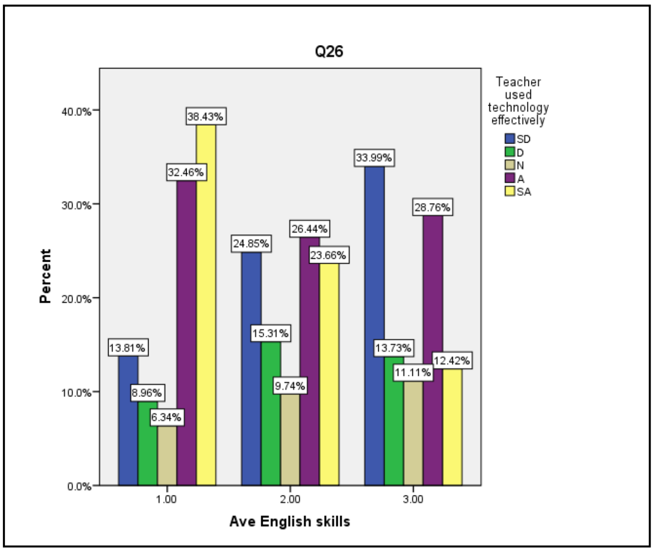

Figure 4-10 Bar chart Q26 versus Students' English Language Ability

4.3.3. Effectiveness of Teachers:

This group consists of questions 11, 15, 16, 17, 18 and 20. Chi-squared tests were conducted to explore the associations between all the questions of effectiveness of teachers and the ten predictor variables in order to obtain the best possible information regarding the pattern of these relationships (*Table 4-20*). In some cases, rows and columns that comprise a small number of students are combined to eliminate the problem of expected values of less than 5. The university variable has significant relationship with all questions relating to effectiveness of teachers except question 11, while the relationship of the college variable is significant with all questions. To explore the influence of institutions on students' responses about the effectiveness of teachers' questions, question 17 is presented, which refers to the interactive exercises that teachers used with students. *Table 4-21* compares the distribution of the question 17 scores, depending on the six different universities that students have attended. Dammam and Jubail universities have the lowest percentages (26% and 20% respectively) of students who are satisfied with interactive exercises used by teachers (scores of 4 or 5), and these universities have the highest percentage (44% and 42% respectively) of students who are dissatisfied with the interactive exercises that teachers used as well (scores of 1 or 2). Furthermore students' responses in the other universities are divided into two groups: students who had positive experiences range between 40% and 46%, and those who had negative experiences range between 31% and 39%. This split may be due to the learning exercises used by the teachers and their suitability for the main subject of students. Certainly, the result shows the impact of universities and colleges that students have attended on their responses about the teachers of statistics courses in those institutions and their teaching approaches. In other words, the university attended has a stronger impact on student views of teacher effectiveness than other variables.

Furthermore, there are significant associations between the number of statistics courses variable and question 15, and between the English language ability variable and question 11. However, the cross-tabulations of these variables with questions do not give us important information where there is no big difference between students' responses within the different groups.

Table 4-20 Chi-square test for Group of Teacher items versus independent variables

		Sex	**Statistics programs**	**Main language**	**Uni**	**Colleges**	**High school**	**Stat courses**	**Hours**	**Study level**	**English ability**
Q11	p-value	.347	.116	.508	.026*	**.001***	.288*	.479*	.165	.119	**.000**
	Cramer's V	.092	.084	.056	.093	.157	.069	.058	.075	.075	.131
Q15	p-value	.943	.304	.019	**.000**	**.000***	.455*	**.003***	.051	.772	.305
	Cramer's V	.038	.068	.106	.154	.274	.059	.125	.086	.051	.067
Q16	p-value	.378	.092	.115	**.000**	**.000***	.068*	.149*	.529	.410	.013
	Cramer's V	.089	.087	.084	.108	.178	.091	.080	.058	.063	.096
Q17	p-value	.684	.006	.390	**.000**	**.000***	.015	.175*	.047	.524	.006
	Cramer's V	.066	.119	.063	.111	.161	.096	.078	.087	.060	.102
Q18	p-value	.046	.111	.050	**.000***	**.000***	.579*	.092*	.046	.428	.020
	Cramer's V	.096	.085	.095	.147	.207	.052	.087	.087	.062	.093
Q20	p-value	.031	.212	.892	**.000**	**.000***	.149*	.127*	.258	.134	.320
	Cramer's V	.143	.075	.033	.108	.178	.081	.084	.070	.075	.067

Table 4-21 Cross-tabulation Q17 versus universities

		Teacher engaged the students using interactive exercises					Total
		1	2	3	4	5	
Universities	King Fahd University	28 17.0%	37 22.4%	34 20.6%	42 25.5%	24 14.5%	165 100.0%
	Dammam University	35 24.1%	29 20.0%	42 29.0%	30 20.7%	9 6.2%	145 100.0%
	King Faisal University	47 11.5%	105 25.6%	87 21.2%	116 28.3%	55 13.4%	410 100.0%
	Al-Imam Muhammad ibn Saud University	17 16.5%	16 15.5%	25 24.3%	30 29.1%	15 14.6%	103 100.0%
	Prince Mohammad University	16 14.4%	19 17.1%	23 20.7%	32 28.8%	21 18.9%	111 100.0%
	Jubail Industrial College	17 17.3%	25 25.5%	36 36.7%	16 16.3%	4 4.1%	98 100.0%
Total		160 15.5%	231 22.4%	247 23.9%	266 25.8%	128 12.4%	1032 100.0%

4.3.4. Relevance of Course:

Questions 12, 13, 14 and 19 comprise this group. Chi-squared tests were conducted with these questions and the predictor variables, and university and college are the variables that have significant relationships with all questions except question 19. Perhaps access to resources which are relevant to the main subject of students (Question 19) is the responsibility of the student, and their ability to access them depends on their English language ability; while the relevance of contents, examples and the importance of the statistics courses (Questions 12, 13 and 14) is considered one of the instituttion’s responsibilities. Also, the using statistical software programs variable has a significant relationship with all questions except question 14 (Table 4-22). Undoubtedly, the results show the important role played by institutions in influencing students' responses about questions of relevance. For example, one important issue is the relevance of statistics courses to the main subject of study of non-specialist students (question 12).

Table *4-23* compares the distribution of the question 12 scores, depending on the different universities that students have attended. King Fahd and Prince Mohammad universities have the highest percentages (62% and 49% respectively) of students who are satisfied with the relevance of their statistics courses to their main subjects (scores of 4 or 5), and the lowest percentages of dissatisfied students (scores of 1 or 2). Conversely, Jubail University has the highest percentage of dissatisfied students (53%) and the lowest percentages of satisfied students (22%). While students’ responses in the other universities are divided into two groups, students who had positive experiences range between 32% and 43%, while those who had negative experiences range between 32% and 40%. Again, this split may be due to the different opinions of students about the relevance of the content of statistics courses for their main subjects.

Furthermore, the path taken through high school, hours of study and number of statistics courses variables have significant relationships with questions 12 and 13; the main language variable has a significant association with question 14 only.

Table 4-22 Chi-square test for Group of Relevance items versus independent variables

		Sex	Statistics programs	Main language	Uni	Colleges	High school	Stat courses	Hours	Study level	English ability
Q12	p-value	.001	**.000**	.009	**.000**	**.000***	**.000***	**.000***	**.000**	.682	.012
	Cramer's V	.194	.158	.115	.145	.203	.149	.143	.118	.055	.098
Q13	p-value	.087	**.000**	.047	**.000**	**.000***	.033*	**.002***	**.000**	.266	.102
	Cramer's V	.126	.150	.097	.155	.213	.101	.127	.127	.069	.080
Q14	p-value	.011	.026	**.000**	**.000**	**.000***	.499*	.452*	.066	.258	.015
	Cramer's V	.160	.104	.142	.135	.188	.057	.060	.085	.069	.096
Q19	p-value	.276	**.002**	.351	.412	.026*	.262*	.297*	.724	.347	.460
	Cramer's V	.102	.133	.067	.073	.141	.072	.070	.052	.067	.063

Table 4-23 Cross-tabulation Q12 versus universities

		Contents of the course were relevant					
		1	2	3	4	5	Total
Universities	King Fahd University	11 6.6%	27 16.2%	25 15.0%	75 44.9%	29 17.4%	167 100.0%
	Dammam University	33 23.1%	25 17.5%	39 27.3%	38 26.6%	8 5.6%	143 100.0%
	King Faisal University	55 13.8%	73 18.2%	115 28.7%	123 30.8%	34 8.5%	400 100.0%
	Al-Imam Muhammad ibn Saud University (Al-Hassa branch)	12 11.5%	24 23.1%	23 22.1%	41 39.4%	4 3.8%	104 100.0%
	Prince Mohammad University	10 9.2%	18 16.5%	27 24.8%	35 32.1%	19 17.4%	109 100.0%
	Jubail Industrial College	24 24.0%	29 29.0%	25 25.0%	18 18.0%	4 4.0%	100 100.0%
Total		145 14.2%	196 19.2%	254 24.8%	330 32.3%	98 9.6%	1023 100.0%

4.3.5. Student Engagement:

This group consists of several questions, including 30, 31, 32 and 33. Chi-squared tests were used to investigate the significant associations between these questions and the predictor variables (*Table 4-24*). The university and college variables are the only variables that have significant association with questions 31 and 32. For instance, one important aim for students of studying statistics courses is their ability to use it in their main subject (question 32). Table 4-25 and *Table 4-26* compares the distribution of question 32 scores depending on the different universities and colleges that students have attended. The first three universities (*Table 4-25*) where students had positive experiences with their ability to apply statistical concepts to their primary field of focus are King Fahd, Al-Imam and Prince Mohammad universities (54%, 47% and 40%, respectively). Therefore, this result indicates the importance of the role that is played by the university and college on students' experiences of engagement. However, it is surprising to have such results from students within Al-imam University, where their responses for the questions in other groups of questions indicated that they have some difficulties and negative experiences with several issues. Therefore, it is encouraging that students finds themselves able to apply the statistical concepts in their main subject.

Table 4-24 Chi-square test for Group of Engagement items versus independent variables

		Sex	**Statistics programs**	**Main language**	**Uni**	**Colleges**	**High school**	**Stat courses**	**Hours**	**Study level**	**English ability**
Q30	p-value	.017	.023	.156	.171	.100*	.149*	.044*	.595	.721	.276
	Cramer's V	.159	.111	.085	.084	.131	.086	.103	.059	.056	.073
Q31	p-value	.044	.016	.014	**.002**	**.000***	.067	.939*	.806	.014	.010
	Cramer's V	.137	.108	.110	.103	.150	.084	.028	.047	.090	.098
Q32	p-value	.021	.156	.011	**.000**	**.000***	.054*	.388*	.280	.720	.040
	Cramer's V	.150	.081	.113	.109	.157	.095	.064	.069	.053	.089
Q33	p-value	.075	.207	.255	.029	.007*	.136*	.632*	.202	.924	.352
	Cramer's V	.128	.076	.072	.909	.139	.082	.050	.073	.049	.066

Table 4-25 Cross-tabulation Q32 versus universities

		Students will be able to apply the statistical concepts in their main subject					Total
		1	2	3	4	5	
Universities	King Fahd University	20 12.0%	13 7.8%	43 25.7%	61 36.5%	30 18.0%	167 100.0%
	Dammam University	29 20.0%	34 23.4%	40 27.6%	33 22.8%	9 6.2%	145 100.0%
	King Faisal University	53 13.1%	65 16.0%	130 32.1%	120 29.6%	37 9.1%	405 100.0%
	Al-Imam Muhammad ibn Saud University	11 10.8%	14 13.7%	28 27.5%	38 37.3%	11 10.8%	102 100.0%
	Prince Mohammad University	20 18.0%	15 13.5%	31 27.9%	39 35.1%	6 5.4%	111 100.0%
	Jubail Industrial College	10 10.4%	14 14.6%	38 39.6%	26 27.1%	8 8.3%	96 100.0%
Total		143 13.9%	155 15.1%	310 30.2%	317 30.9%	101 9.8%	1026 100.0%

Table 4-26 Cross-tabulation Q32 versus colleges

		Students will be able to apply the statistical concepts in their main subject					Total
		1	2	3	4	5	
Colleges	Fahad_College of Industrial Management	8 13.1%	4 6.6%	20 32.8%	23 37.7%	6 9.8%	61 100.0%
	Fahd_College of Computer Science	6 12.0%	1 2.0%	9 18.0%	22 44.0%	12 24.0%	50 100.0%
	Fahd_College of Engineering Sciences	6 10.7%	8 14.3%	14 25.0%	16 28.6%	12 21.4%	56 100.0%
	Dammam_College of Education	14 24.1%	19 32.8%	11 19.0%	11 19.0%	3 5.2%	58 100.0%
	Dammam_College of Architecture & Planning	11 23.9%	6 13.0%	15 32.6%	12 26.1%	2 4.3%	46 100.0%
	Dammam_College of Engineering	4 9.8%	9 22.0%	14 34.1%	10 24.4%	4 9.8%	41 100.0%
	Faisal_College of Business	12 10.3%	18 15.4%	41 35.0%	34 29.1%	12 10.3%	117 100.0%
	Faisal_College of Education	21 16.4%	26 20.3%	39 30.5%	35 27.3%	7 5.5%	128 100.0%
	Faisal_College of Computer Science	11 13.9%	16 20.3%	22 27.8%	21 26.6%	9 11.4%	79 100.0%
	Faisal_College of Agricultural and Food Science	6 8.8%	5 7.4%	21 30.9%	27 39.7%	9 13.2%	68 100.0%
	Faisal_College of Engineering	3 23.1%	0 0.0%	7 53.8%	3 23.1%	0 0.0%	13 100.0%
	Imam_College of Shariah and Islamic Studies	11 10.8%	14 13.7%	28 27.5%	38 37.3%	11 10.8%	102 100.0%
	Mohammed_College of Computer Engineering and Science	2 9.1%	5 22.7%	9 40.9%	5 22.7%	1 4.5%	22 100.0%
	Mohammed_College of Business Administration	18 20.2%	10 11.2%	22 24.7%	34 38.2%	5 5.6%	89 100.0%
	Jubail_Mechanical Engineering Technology	10 10.4%	14 14.6%	38 39.6%	26 27.1%	8 8.3%	96 100.0%
Total		143 13.9%	155 15.1%	310 30.2%	317 30.9%	101 9.8%	1026 100.0%

4.4. Multilevel Modelling

Some simple multilevel modelling of individual questions is now presented, as an indication of more complex modelling that could be carried out on the questionnaire data.

As explained in chapter three, the multilevel generalized linear model for dichotomous outcome variable is conducted separately, with one question from each of the groups of questions considered previously. Either department or college is included as the middle level for the models, as the difference between department and college does not seem to be really important. Six models are identified for each question in order to choose the best model for that question: random intercept models with two levels (see Equation 3.4) and three levels (Equation 3.6), Table 4.27; models with predictor variables at the student level (Equations 3.5 and 3.7), Table 4.28.

For each group, the individual question selected focussed on an important issue, and was analysed separately using multilevel generalized linear models for ordinal outcome variables. In all cases, the two-level models (students within universities) ran successfully. However, the equivalent analysis at three levels would not run because the number of cells in the equivalent cross-tabulation (university x college/department x response on a Likert scale) was too large and many of the cells were empty; this problem would potentially arise for all individual questions. To overcome this problem, it was decided to treat the responses as binary, and the raw outcomes were re-categorised in two different ways. The first way is (1 = SA/ 2 = A against 3 = N/ 4 = D/ 5 = SD) and the second way is (1 = SA/ 2 = A against 4 = D/ 5 = SD, 3 = N is missing). In this section, I will focus particularly on the issue of English language and technology use; these aspects of learning represent the main issues examined within this study, so I will spend time discussing the results of those questions in greater detail.

English Language. Based on the difficulties in using statistical software programs caused by lack of English language skills, question 36 was selected to present the issues of English language comprehension. Comparing the results for this question in *Table 4-27* and *Table 4-28***Error! Reference source not found.**, models with variables have slightly smaller values of AIC and BIC than the equivalent simple models. The final model of this question is a logistic mixed effect three-level model (student within department, within university), where it has the lowest value of AIC = 1067 and BIC = 1086 (*Table 4-28*). The student-level variable added in this case is *English Language Ability* and this variable slightly improves the model, reducing the AIC and BIC values from those shown in *Table 4-27***Error! Reference**

source not found. for the simple models. The difference among the AIC and BIC values for the three models that include this variable is very small. The formula of this model is:

$$\ln\left(\frac{p(y=1)}{1-p(y=1)}\right) = \gamma + u_k + u_{jk} + \beta_1(English\ Language\ Ability)_{jk}$$

$$u_k \sim N\left(0,\ \sigma_k^2\right) \qquad u_{jk} \sim N\left(0,\ \sigma_{jk}^2\right)$$

The model value of intercept is $\hat{\gamma} = 3.0599$ and the estimate of its standard error is 0.36. The variation is presented as the standard deviation of the variance which are, $\hat{\sigma}_k = 0.25$, $\hat{\sigma}_{jk} = 0.57$. With regard to the slope of *English Language Ability*, the estimate of β_1(a fixed effect) is -1.78 and the estimate of its standard error is 0.18. This indicates a negative relationship: where the English language ability score increases, the log odds that students had positive experiences with English language skills in using statistical programs reduces. This indicates that students whose English language ability is poor (where 3 represents the poorest level of ability), are more dissatisfied with their English language skills in using statistical software programs in learning and teaching statistics. The AIC and BIC values had similar behaviour for both re-coding schemes.

Using Technology. Question 26, which illustrates the effectiveness of using technology by teachers in different colleges, is presented here to give a clear picture of technology issues. Comparing the results for this question in *Table 4-27* and *Table 4-28***Error! Reference source not found.**, models with variables have slightly smaller values of AIC and BIC than the equivalent simple models. However, it is clear that the addition of the *Using Statistics programs* variable slightly improves the model, reducing the AIC and BIC values from those shown in *Table 4-27***Error! Reference source not found.** for the simple models. There is very little difference among the AIC and BIC values for the three models that include this variable, though the three-level model (student within department within university) has the lowest AIC and BIC. The final model of this questions is, therefore, a random intercept multilevel model three-level (student within department, within university) where it has the lowest value of AIC = 971 and BIC = 990 (*Table 4-28*) and the formula of this model is:

$$\ln\left(\frac{p(y=1)}{1-p(y=1)}\right) = \gamma + u_k + u_{jk} + \beta_1(Using\ Statistics\ programs)_{jk}$$

$$u_k \sim N\left(0,\ \sigma_k^2\right) \qquad u_{jk} \sim N\left(0,\ \sigma_{jk}^2\right)$$

The variation is presented as the standard deviation of the variance of u_k and u_{jk} terms which are $\hat{\sigma}_k = 1.5698$ and $\hat{\sigma}_{jk} = 0.9675$ respectively. The model value of intercept is $\hat{\gamma} = -0.2993$ and the estimate of its standard error is 0.68. With regard to the slope of *Using Statistics programs* fixed effect, we see that higher scores (0 refer to No and 1 refer to Yes), are associated with greater log odds of students' satisfaction of technology use by their teachers with slope being 0.7622 ($p<0.001$) and the estimate of its standard error is 0.19. The results are statistically significant and lead to the conclusion that students' use of statistical software programs is positively related to the likelihood of students' satisfaction with their teachers' use of technology. The AIC and BIC values had similar behaviour for both re-coding schemes in the two-level model (student within university), but in the three-level model there is very little difference, while the random intercept multilevel three-level model (student within college, within university) has the lowest value of AIC and BIC.

Table 4-27 AIC and BIC Values for Simple Logistic Models in Questions 26 and 36

Question		**Two-level intercept (Student/ University)**	**Three-Level intercept (Student/ College/ University)**	**Three-Level intercept (Student/ Department/ University)**
(Re-coded as SA/A against N/D/SD)				
Q26	**AIC**	1033.3	985.8	983.4
	BIC	1043.0	1000.3	997.9
Q36	**AIC**	1203.6	1177.1	1165.9
	BIC	1213.3	1191.5	1180.4
(Re-coded as SA/A against D/SD; N is missing)				
Q26	**AIC**	878.5	812.3	822.6
	BIC	888.0	826.5	836.8
Q36	**AIC**	961.1	939.8	938.9
	BIC	970.3	953.7	952.8

Table 4-28 AIC and BIC Values for Logistic Models with variables in Questions 26 and 36

Question		**Two-level variables (Student/ University)**	**Three-Level variables (Student/ College/ University)**	**Three-Level variables (Student/ Department/ University)**
(Re-coded as SA/A against N/D/SD)				
Q26	**AIC**	1023.0	971.5	970.7
	BIC	1037.5	990.8	990.0
Q36)	**AIC**	1083.0	1076.0	1066.9
	BIC	1097.5	1095.3	1086.2
(Re-coded as SA/A against D/SD; N is missing)				
Q26	**AIC**	859.2	793.3	806.3
	BIC	873.4	812.2	825.3
Q36	**AIC**	827.3	827.6	825.3
	BIC	841.1	846.0	843.8

The model that has been used, is logistic with random effects. Logistic model because each of response variables in our research is binary while the random effect components are used because we have varied subjects and levels such as different departments within different universities. More details about this model can be found for example in Molenberghs & Verbeke (2005). After selecting the final model for questions 26 and 36, checking model assumptions is required in order to determine whether the model is adequate and the assumptions of multi-level logistic modelling are met. One of these assumptions is the measurements are independent (for both between subjects or between cluster such as department or university) since we have varied subjects/elements that have been measured (Molenberghs & Verbeke 2004; Carlin, Brown & Celman 2001). Model assumptions were checked in this way for all other questions as well that were selected from different groups of questions, and there was no evidence that the assumptions were violated in any case.

4.5. Factor Analysis

Kaiser-Meyer-Olkin measure: Factor analysis was conducted on 22 items (individual variables) of the satisfaction of non-specialist students toward statistics courses, in order to reduce the number of variables to be analysed. A model with five factors was found to fit the data well. The Kaiser-Meyer-Olkin measure aims to verify whether the sample is big enough and the adequacy of the factor analysis. It indicates the amount of variance within the data that could be explained by the factor analysis model – its value should not be less than 0.5 to be acceptable (Brace et al. 2006). Furthermore, Bartlett's Test of Sphericity indicates the factorability of the data. For this dataset, KMO=0.82, which is well above the acceptable limit of 0.5 and Bartlett's test gives chi square = 4718.69, p-value < 0.001, indicating that correlations between items might be sufficiently large to make factor analysis useful (*Table 4-29*).

Table 4-29 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.819
Bartlett's Test of Sphericity	Approx. Chi-Square	4718.686
	df	231
	Sig.	.000

Anti-image correlation matrix: This matrix identifies the pairwise correlations between variables as the off-diagonal elements and the KMO values for each variable as the diagonal elements. All variables should have a KMO value more than 0.5, otherwise this variable might have to be excluded from the analysis (Brace et al. 2006). *Table 4-30* shows that each variable of the 22 variables has a KMO value greater than 0.6 and indicates that the correlations between some pairs of items might be sufficiently large to make factor analysis useful.

Table 4-30 Anti-Image Correlation Matrix

Items	11	12	13	14	15	16	17	18	19	20	26	27	28	29	30	31	32	33	34	35	36	37
11	.884[a]																					
12	-.040	.846[a]																				
13	-.043	-.517	.826[a]																			
14	.071	-.210	-.273	.908[a]																		
15	-.136	.002	-.011	.021	.861[a]																	
16	-.179	.008	-.023	-.072	-.188	.866[a]																
17	-.075	-.038	.021	-.111	.083	-.408	.851[a]															
18	-.165	-.027	.058	-.115	-.158	-.122	-.158	.864[a]														
19	.029	-.007	.005	.093	.017	-.084	.016	-.015	.711[a]													
20	-.055	-.013	-.094	.080	-.181	-.032	-.070	-.064	.007	.910[a]												
26	-.096	.039	-.093	-.035	-.027	.026	-.060	-.108	-.085	.013	.769[a]											
27	.033	.012	.010	-.036	.017	-.050	-.149	.174	-.019	-.059	-.311	.727[a]										
28	-.025	-.019	-.028	-.028	.099	.024	.079	-.045	-.050	.055	-.074	-.332	.679[a]									
29	.056	-.005	-.057	-.001	-.083	-.061	-.020	.011	.018	-.050	-.099	-.119	-.034	.893[a]								
30	.068	.099	-.087	-.031	-.042	.106	-.092	.018	-.005	-.030	.067	-.179	-.049	-.116	.767[a]							
31	-.083	-.093	.055	-.026	.018	-.125	-.088	.026	-.032	-.156	.138	.036	-.007	.006	-.094	.906[a]						
32	.064	-.093	.017	-.042	-.078	-.034	-.032	.002	.049	-.027	-.001	-.047	.062	-.027	.021	-.200	.807[a]					
33	-.061	-.052	-.042	-.069	.002	-.008	.100	-.009	.003	-.006	-.060	-.038	.012	.021	-.093	-.124	-.639	.794[a]				
34	.059	-.089	.052	.018	.060	.022	-.045	-.046	.070	.013	-.037	.055	.090	-.021	.041	-.065	.089	-.064	.761[a]			
35	-.053	-.009	-.001	.011	.011	.004	.021	.008	-.021	-.059	-.017	-.029	.041	.017	-.035	-.038	-.038	.038	-.429	.791[a]		
36	-.039	-.066	.038	.054	.090	-.027	.050	-.014	.032	-.041	-.108	.016	.029	-.008	.019	.041	-.052	.126	-.114	-.280	.699[a]	
37	.042	.010	-.059	.045	-.090	.037	-.032	.018	.053	.046	.045	-.028	-.010	-.039	-.004	.085	.082	-.169	.013	-.110	-.658	.687[a]

a. Measures of Sampling Adequacy (MSA)

Communalities: This measures how much variance in each variable is explained by the model. *Table 4-31* shows the communalities of the variables in this part of the questionnaire. In factor analysis the initial communalities are equal to one because all possible components are calculated at that point, which indicates that all the variance is explained. The extraction communalities are calculated using the extracted factors only. Item 36 (Lack of English language skills) has the highest proportion (79%) of variance that can be explained by the extracted factors, while only 16% is explained for item 19 (It is difficult to find statistics resources) which has the lowest proportion.

Table 4-31 Communalities

	Initial	Extraction
Teacher was knowledgeable about statistics	1.000	.495
Contents of the course were relevant	1.000	.752
Examples which were used in the course were relevant	1.000	.715
Importance of the course was clarified at the beginning	1.000	.679
Criteria which were used were clarified at the beginning	1.000	.438
Teaching methods used by the teacher helped student to learn effectively	1.000	.650
Teacher engaged the students using interactive exercises	1.000	.533
Teacher was receptive to students' questions	1.000	.526
Student was able to complete the work of the course in the time available	1.000	.421
Teacher used technology effectively	1.000	.528
Enough time was spent in learning and using a statistical software program	1.000	.332
Students could have used technology to learn statistics without teacher	1.000	.486
Students are enjoying studying statistics	1.000	.589
Students will be able to apply the statistical concepts in their main subject	1.000	.714
Students will be able to apply the statistical concepts in their future employment	1.000	.690
Recode_It is difficult to find statistics resources that were relevant to the main subject	1.000	.162
Recode_Using software program led student to concentrate on the technology	1.000	.669
Recode_Using software program to compute problems caused misunderstanding of some steps of statistical procedures	1.000	.508
Recode_Technical words which are not translated into their language make it difficult to learn statistics	1.000	.539
Recode_Most statistical software programs are in English and this make it difficult to learn statistics	1.000	.692
Recode_Lack of English language skills is an obstacle to using statistical software programs	1.000	.788
Recode_English language skills has prevented students from accessing statistics resources in the English language	1.000	.693

Extraction Method: Principal Component Analysis.

Total variance explained: This summarises the total variance explained by the factor analysis. There are three sections of the total variance explained. *Table 4-32* lists the eigenvalues associated with each component before extraction, after extraction and after rotation. The first section (Initial Eigenvalues) shows the eigenvalues for all possible components (factors). There are 22 possible components (factors), which is the same as the number of variables entered into the analysis, and they are ranked in order of how much variance each accounts for. It is important to note that each variable is not a component by itself. For instance, factor 1 explains 23.59% of the total variance (*Table 4-32*). The second section (Extraction Sums of Squared Loadings) extracts all components (factors) with eigenvalues greater than one; with the 22 items there are five factors with an eigenvalue greater than one (*Figure 4-11*). The five extracted factors together explain 57.27% of the variance. The third section (Rotation Sums of Squared Loadings) contains the eigenvalues of the factors after rotation has been carried out and the structure of the factors is affected by rotation. Factor one accounted for a lot more variance than the other four factors before rotation (23.59% compared to 12.9, 8.53, 6.98 and 5.25%), but after rotation the variance value became 13.8%, compared to 12.89, 11.58, 9.19 and 9.79% respectively. However, the cumulative percentage of variance explained by all of the extracted factors has not changed after rotation.

Table 4-32 Total Variance Explained

Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Eigenvalue	**% of Variance**	**Cumulative %**	**Eigenvalue**	**% of Variance**	**Cumulative %**	**Eigenvalue**	**% of Variance**	**Cumulative %**
5.190	23.590	23.590	5.190	23.590	23.590	3.037	13.803	13.803
2.839	12.906	36.497	2.839	12.906	36.497	2.837	12.897	26.700
1.877	8.531	45.027	1.877	8.531	45.027	2.548	11.580	38.280
1.536	6.983	52.010	1.536	6.983	52.010	2.155	9.796	48.076
1.156	5.256	57.267	1.156	5.256	57.267	2.022	9.191	57.267
.970	4.411	61.677						
.883	4.014	65.692						
.866	3.936	69.628						
.777	3.533	73.161						
.735	3.339	76.499						
.688	3.128	79.628						
.674	3.062	82.690						
.620	2.817	85.506						
.575	2.615	88.121						
.442	2.011	90.132						
.407	1.850	91.982						
.395	1.797	93.778						
.355	1.614	95.393						
.336	1.528	96.921						
.273	1.241	98.162						
.225	1.024	99.186						
.179	.814	100.000						

Extraction Method: Principal Component Analysis.

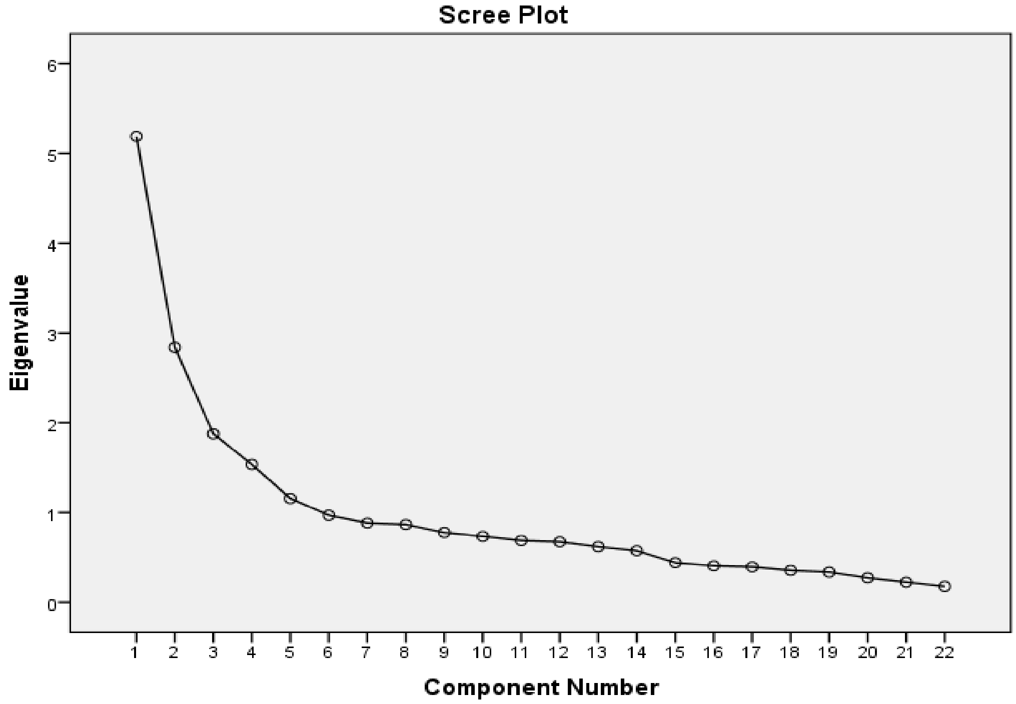

Figure 4-11 The Scree Plot of the Components and their Eigenvalue

Rotated component matrix: This matrix contains the factor loadings for each variable after rotation is carried out. Variables with high loading onto specific factors might be seen as particularly connected to that factor. *Table 4-33* determines the loading of variables onto the five factors obtained from the previous step. The five factors contain the following variables: factor one (variables 11, 15, 16, 17, 18 and 20) can be interpreted as 'Effectiveness of Teachers'; factor two (variables 34, 35, 36 and 37) can be interpreted as 'English Language'; factor three (variables 12, 13 and 14) can be interpreted as 'Relevance of Course'; factor four (variables 30, 31, 32 and 33) can be interpreted as 'Student Engagement'; finally, factor five (variables 26, 27, 28 and 29) can be interpreted as 'Using Technology'. However, variable 19 has a low loading on each factor (*Table 4-33*) and the lowest communality (*Table 4-31*). Therefore, this variable is excluded from the analysis.

Table 4-33 Rotated Component Matrix

	Variables	Component				
		1	2	3	4	5
11	Teacher was knowledgeable about statistics.	.690	.023	.131	-.007	.020
12	Contents of the course were relevant.	.228	.106	.810	.173	.051
13	Examples which were used in the course were relevant.	.181	.027	.793	.137	.186

14	Importance of the course was clarified at the beginning.	.232	-.126	.753	.149	.140
15	Criteria which were used were clarified at the beginning.	.599	-.037	-.006	.280	-.007
16	Teaching methods used by the teacher helped student to learn effectively.	.751	-.078	.201	.169	.103
17	Teacher engaged the students using interactive exercises.	.650	-.048	.210	.138	.213
18	Teacher was receptive to students' questions.	.702	.008	.165	-.070	-.027
20	Student was able to complete the work of the course in the time available.	.492	.081	.026	.412	.049
26	Teacher used technology effectively.	.249	.160	.185	-.129	.624
29	Enough time was spent in learning and using a statistical software program.	.148	.097	.025	.269	.476
30	Students could have used technology to learn statistics without teacher.	-.090	-.056	-.061	.557	.401
31	Students are enjoying studying statistics.	.353	-.100	.249	.617	-.105
32	Students will be able to apply the statistical concepts in their main subject.	.217	-.035	.439	.687	.000
33	Students will be able to apply the statistical concepts in their future employment.	.161	.007	.458	.673	.037
19	Recode_It is difficult to find statistics resources that were relevant to the main subject.	-.131	.217	.200	.105	-.215
27	Recode_Using software program led student to concentrate on the technology.	-.044	.029	-.101	-.200	-.785
28	Recode_Using software program to compute problems caused misunderstanding of some steps of statistical procedures.	.148	.198	-.098	.121	-.650
34	Recode_Technical words which are not translated into their language make it difficult to learn statistics.	.026	.719	.040	-.007	-.139
35	Recode_Most statistical software programs are in English and this make it difficult to learn statistics.	.047	.830	-.006	.031	-.014
36	Recode_Lack of English language skills is an obstacle to using statistical software programs.	-.038	.878	-.039	-.107	.058
37	Recode_English language skills have prevented students from accessing statistics resources in the English language.	-.072	.824	-.005	-.029	.090

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Negative values: The rotated component matrix (*Table 4-33*) indicates that variables 27 and 28 in factor five have negative coefficients after being reverse-coded (-0.785 and -0.65 respectively), which means that they are pointing in the opposite direction from the other variables in the same factor. The Kendall Tau-b Correlation Coefficient Test is conducted to verify whether the variables in factor five are correlated and have the same direction or not. *Table 4-34* shows that all items are significantly correlated with each other (p-value less than

.01), but items 27 and 28 have negative correlations with the other items (opposite direction) in that factor. Therefore, variables 27 and 28 do not appear to need reverse coding.

Table 4-34 Correlation of Factor Five's Variables

			Teacher used technology effectively	Enough time was spent in learning and using a statistical software program	Recode_Using software program led student to concentrate on the technology	Recode_Using software program to compute problems caused misunderstanding of some steps of statistical procedures
Kendall's tau_b	Teacher used technology effectively	Correlation Coefficient	1.000	.227**	-.379**	-.169**
		Sig. (1-tailed)	.	.000	.000	.000
		N	924	775	800	760
	Enough time was spent in learning and using a statistical software program	Correlation Coefficient	.227**	1.000	-.235**	-.116**
		Sig. (1-tailed)	.000	.	.000	.000
		N	775	823	763	762
	Recode_Using software program led student to concentrate on the technology	Correlation Coefficient	-.379**	-.235**	1.000	.357**
		Sig. (1-tailed)	.000	.000	.	.000
		N	800	763	832	762
	Recode_Using software program to compute problems caused misunderstanding of some steps of statistical procedures	Correlation Coefficient	-.169**	-.116**	.357**	1.000
		Sig. (1-tailed)	.000	.000	.000	.
		N	760	762	762	806

**. Correlation is significant at the 0.01 level (1-tailed).

Reliability: Cronbach's alpha was used to measure the internal consistency of the factors. *Table 4-35* shows that the alpha coefficients are all greater than .6, which indicates that the reliability of each factor is at least acceptable.

Table 4-35 Cronbach's Alpha of Factors

Factors	No. of Items	Cronbach's alpha
1	6	.77
2	4	.85
3	3	.82
4	4	.71
5	4	.63

Calculating factor scores: The factor scores of responses are calculated by taking an average of an individual's scores over all the variables that make up the factor, so the lowest possible value of any score is 1 (indicating strong dissatisfaction with that aspect of their experience) and the highest possible value is 5. The following figures (4, 5, 6, 7 and 8) show the comparison of factor scores for participants at different universities. *Figure 4-12* shows the convergence of participants' responses towards statistics teachers' effectiveness at their universities (Factor one). The differences in participants' responses to the influence of English language in statistics courses (Factor two) are obvious; students in some institutions have higher levels of agreement than others (

Figure 4-13). Also, there are differences between students' responses about the relevance of statistics courses to their main subjects (Factor three) at different universities, and it is clear that students in Jubail Industrial College recorded lower scores (*Figure 4-14*). However, there is no clear difference in the desire of students to study statistics (Factor four) at different universities (

Figure 4-15). *Figure 4-16* shows how students hold quite different opinions about using technology in statistics courses (Factor Five) at different universities; the responses of participants at Prince Mohammed University were at the highest level, while students' responses at Jubail Industrial College were at the lowest level.

One tentative conclusion would be that these results are consistent with the existing literature, this is perhaps not surprising: I wrote the questions to investigate these themes and they appear to be grouping in the way I expect. However, I am wary about this explanation because if I asked these same questions with another group of people in different places, I may get a different coefficient, loading and I might get a different grouping of questions. Therefore, I can present these results at this time, where the questions address the themes of this study, but it would left to other researchers, perhaps to use the questionnaire again and confirm the results of the questions and their groups.

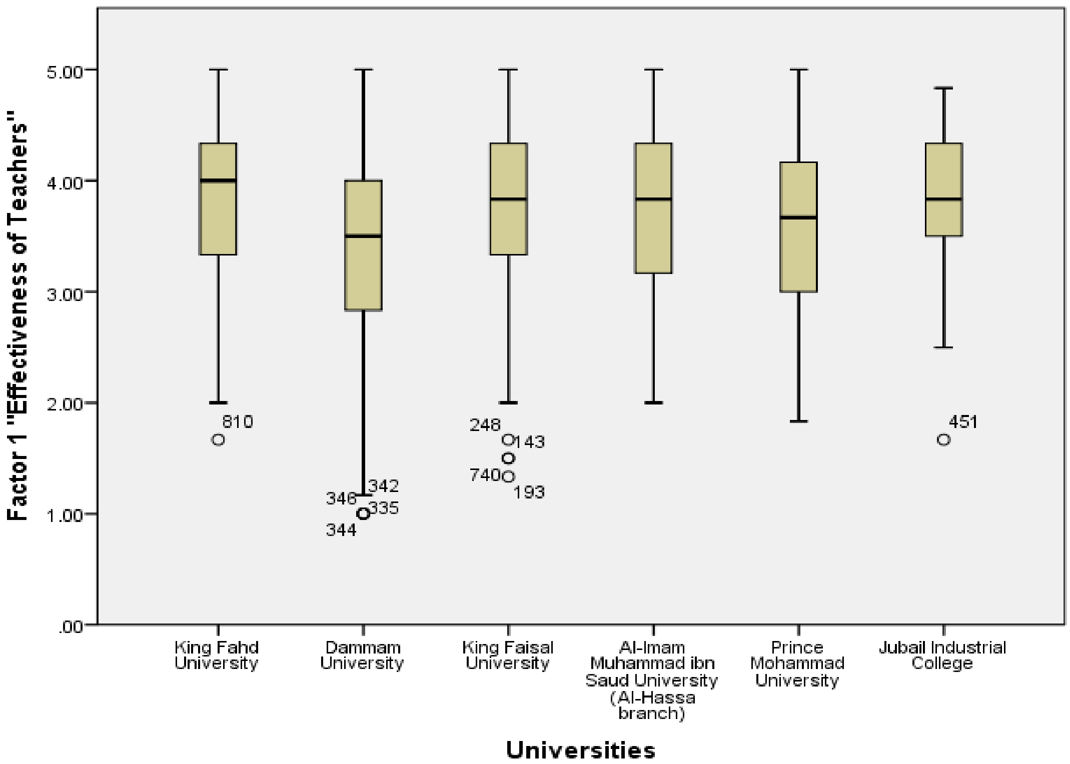

Figure 4-12 Factor One (Effectiveness of Teachers) Scores for Participants at Different Universities

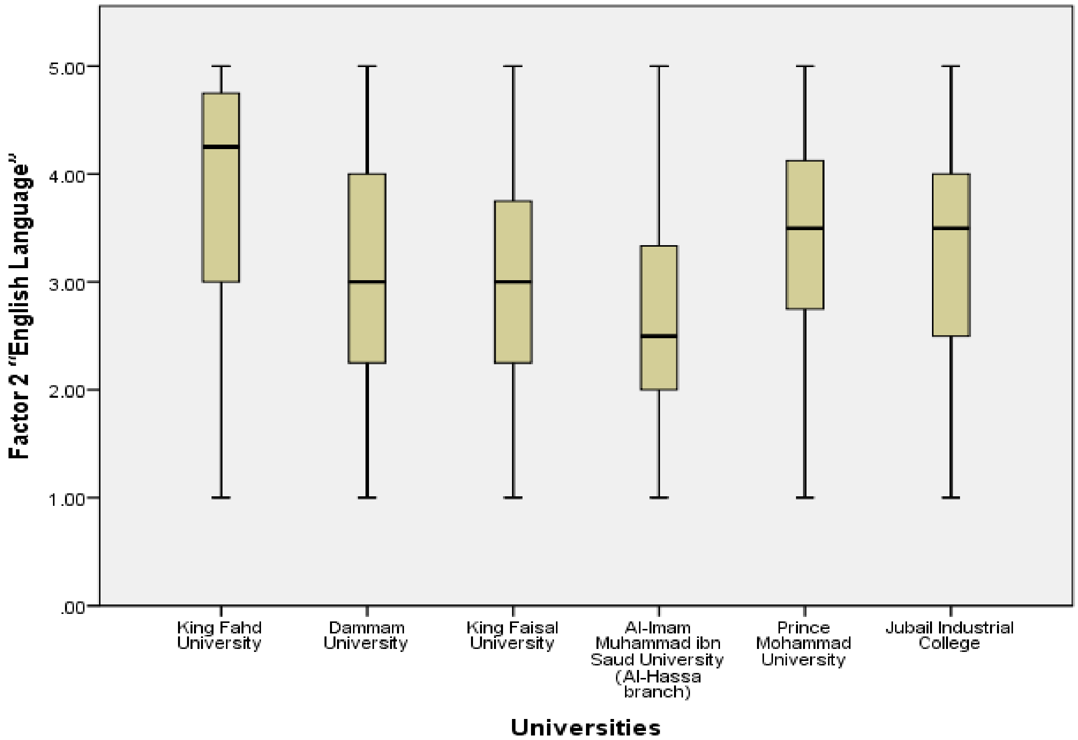

Figure 4-13 Factor Two (English Language) Scores for Participants at Different Universities

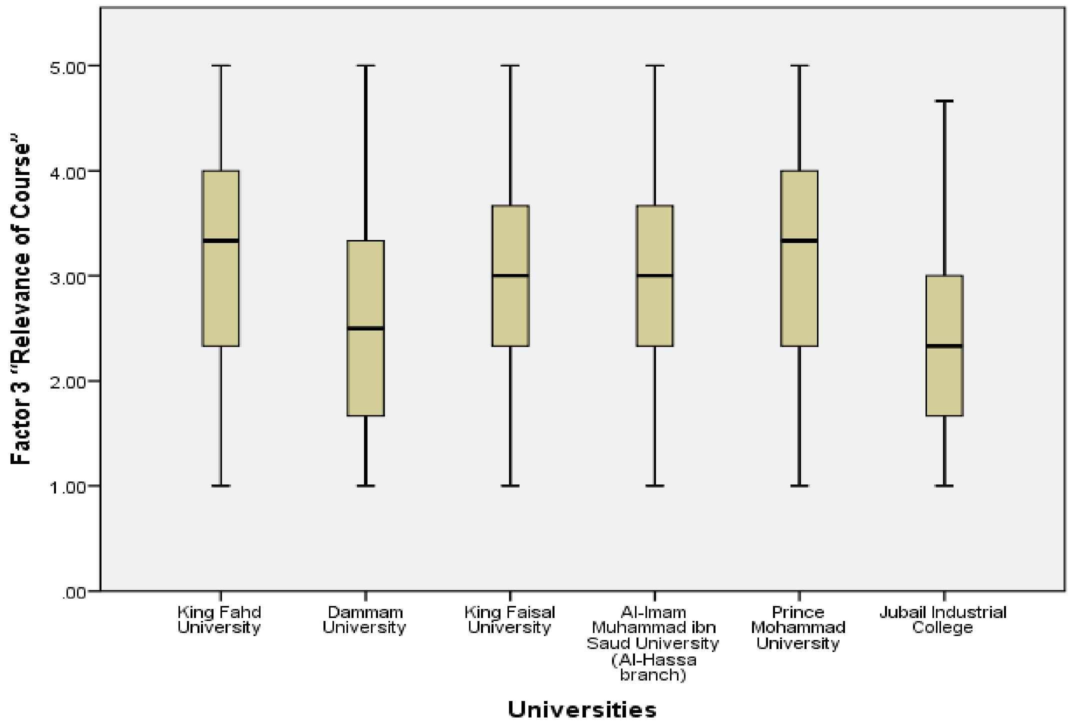

Figure 4-14 Factor Three (Relevance of Course) Scores for Participants at Different Universities

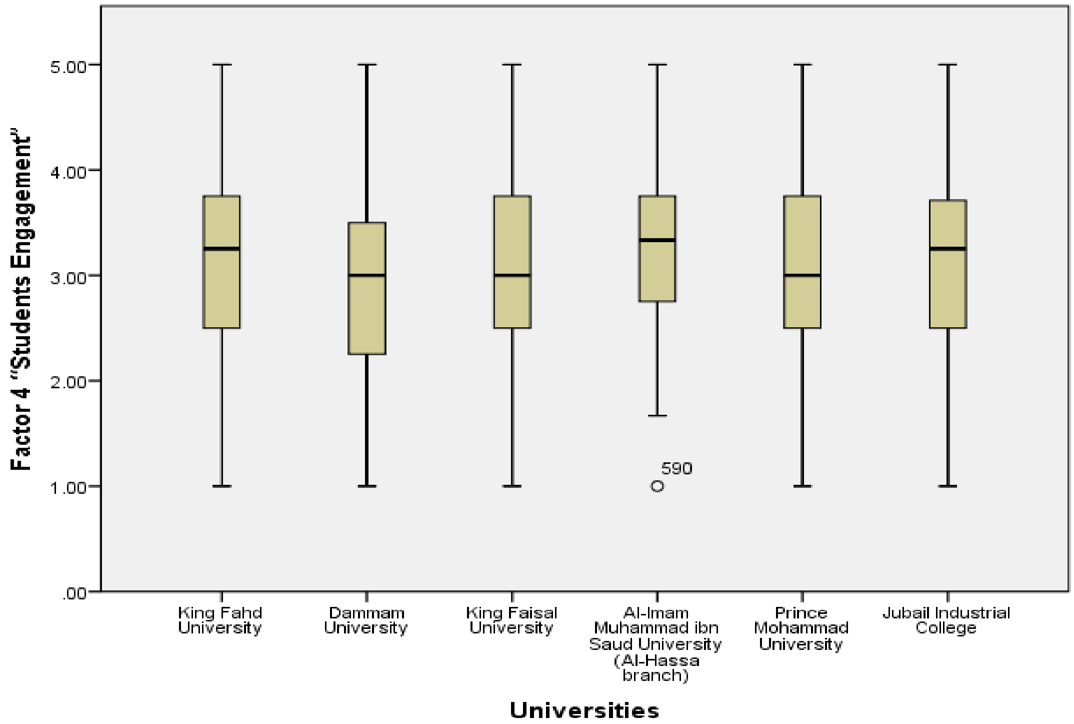

Figure 4-15 Factor Four (Students Engagement) Scores for Participants at Different Universities

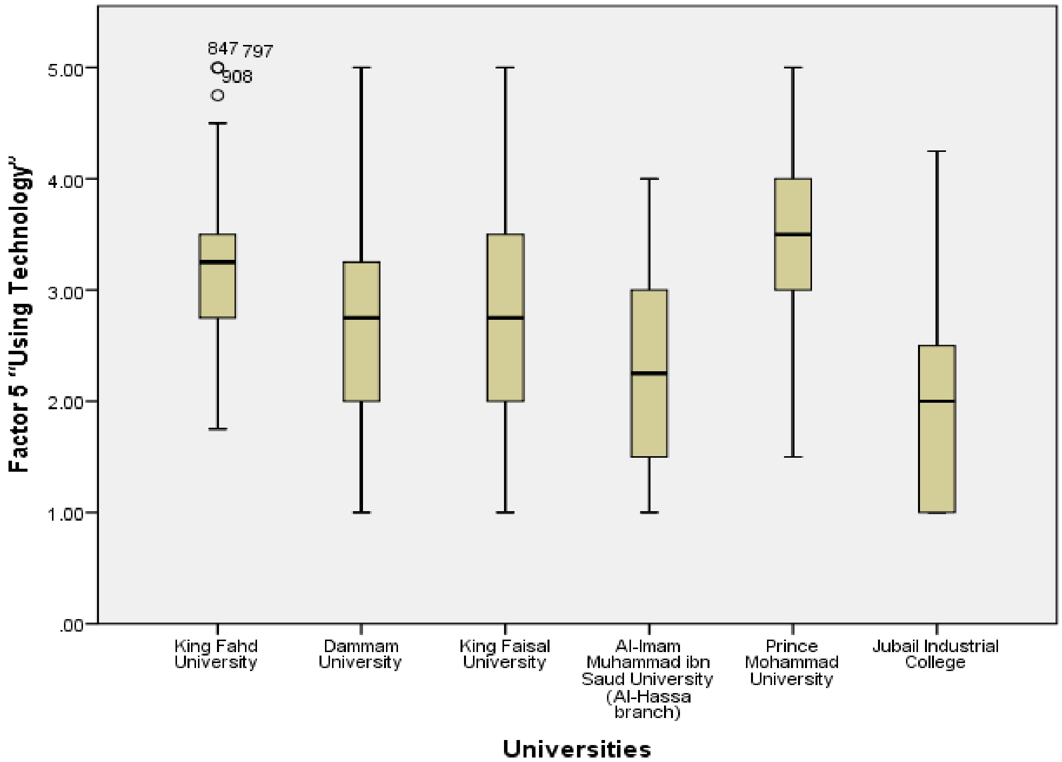

Figure 4-16 Factor Five (Using Technology) Scores for Participants at Different Universities

Students' responses by discipline. We investigated whether there is a similarity between students' responses based on their main subjects or not. For example, *Figure 4-17* shows the comparison of question 36 scores for participants from different academic departments. From the plot we can see that the difference is not between disciplines but appears to be more institutional. Furthermore, by looking at the box plot for the other questions (see appendix K), no evidence emerges that the students' subject of study has a systematic effect on any of the question scores.

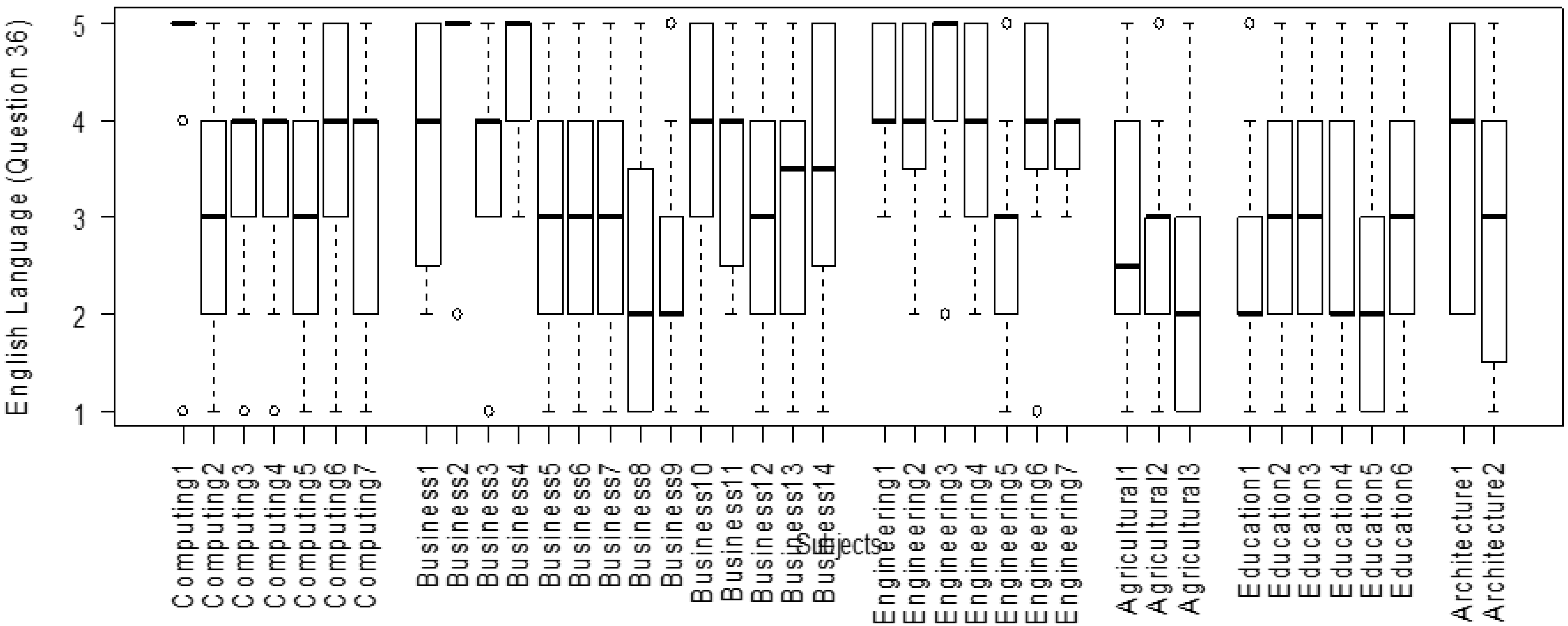

Figure 4-17 English Language (Question 36) Scores for Participants from Different Academic Departments (Discipline)

4.6. Open-ended Questions

Non-specialist students were asked six open-ended questions. The first question refers to the two most important things that helped the students in learning statistics on their courses. The responses that were obtained represent 68% of the total responses that could have been obtained from the students in this question, since some students did not answer the question at all and others gave only one response. The largest number of student responses (37%) mentioned the effectiveness of teachers and the teaching methods used. The regular practice of statistical concepts is considered the second most important thing. Furthermore, the respondents indicated that the presence of their friends on the course and its relevance are ranked, respectively, as the third and fourth most important thing in learning statistics. However, it is notable from the students' responses that the first important thing in this question reflects factor one above (The effectiveness of teachers), the fourth reflects factor three (The relevance of course) and the fifth reflects factor five (Using technology). *Table 4-36* presents the summary of the students' responses.

Table 4-36 Frequencies of Students' Responses to the Important Things that Helped the Students in Learning of Statistics

	Student responses	Frequency	Percent
1	Teachers and the teaching methods	533	37%
2	Examples and projects	160	11%
3	Friends	149	10%
4	Relevance of contents and course	124	9%
5	The use of technology and internet	122	8%
6	Good background and love math/stat	115	8%
7	Self-study	79	5%
8	Book	74	5%
9	Homework and quizzes	51	3%
10	Other	79	5%

The second open-ended question asks about the two most important things that hindered the students' learning of statistics on their courses. The responses obtained in this question represent 47% of the total responses that could have been obtained from the students. A summary of these responses is presented in *Table 4-37*. 26% of students' responses in this question indicated that the irrelevance of the statistical courses and their contents is the most important thing that hindered the students in the learning of statistics. Moreover, the ineffectiveness of teachers and teaching methods is indicated as the second important thing. Furthermore, 10% of students' responses indicated that the scheduled time for statistics courses is insufficient to learn statistics effectively. Again, it is notable that the first important thing that hindered the students' learning of statistics is related to factor three (The relevance of the course) and the second is related to factor one (The effectiveness of teachers).

Table 4-37 Frequencies of Students' Responses to the Important Things that Hindered the Students in the Learning of Statistics

	Student responses	Frequency	Percent
1	Irrelevance of contents and course	264	26%
2	Teachers and the teaching methods	191	19%
3	Not enough time	105	10%
4	The difficulties in equations and calculations	81	8%
5	Examples and projects	45	4%
6	The classroom and its facilities	43	4%
7	Poor background and understanding	41	4%
8	Book	38	4%
9	Not using technology	36	4%
10	English language and technical word	25	3%
11	Students not studying enough	18	2%
12	Exams/final exam	15	1%
13	No teamwork	14	1%
14	Using technology	13	1%
15	Other	66	6%

The third open-ended question that students are asked is, have you ever studied a statistics course at another university? If yes; at what university? Country? How did this course compare to the most recent statistics course you studied in this university. 1000 participants (95%) have not studied a statistics course at another university and 53 participants (5%) have (*Table 4-38*). 38 from 53 participants responded to the second part of the question. 32 participants have studied statistics course at another Saudi university. Students' comparisons between this course and the last statistics course in their universities are summarized in the following: no different, topics more difficult, the use of technology, teacher is better, more application in statistics, use Arabic/English as the main language and more contents of the course. Furthermore, only 6 participants have studied outside Saudi Arabia. One participant from King Fahad University has studied at Kaist University in South Korea and he mentioned that the course was very difficult to understand. Three participants have studied in USA, two of them found that there was no difference, while one participant who has studied at Michigan University noted that the American course was focused on the concepts of statistics and theory rather than its application but in Prince Mohammed University the course was based on how to apply statistical concepts. The last two participants had studied in Canada and New Zealand and they found there to be no difference.

Table 4-38 Frequencies of Students' Responses to the statistics courses they have studied at another university

Student responses	Frequency
Yes	53
No	1000
Saudi universities	32
International universities	6

The fourth open ended question was 'What are the most important challenges students have faced in learning statistics?' The responses obtained in this question represent 21% of the total responses that could have been obtained from the students. The difficulty of the statistics course and the quality of their teachers are the aspects that students find most challenging when learning statistics, indicated by 22% and 20% of student responses, respectively. Insufficient time allocated for statistics courses is considered a third challenge. Furthermore, 12% of student responses indicated that a weaker background in mathematics and statistics is a challenge for non-specialist students in their learning of statistics. However, it is notable from students' responses that the second important challenge for non-specialist students in their learning of statistics is related to factor one (The effectiveness of teacher), the fifth is related to factor two (English language), the eighth is reflected factor five (Using technology) and the tenth is related to factor four (Students engagement). *Table 4-39* presents the summary of these challenges.

Table 4-39 Frequencies of Students' Responses to the Most Important Challenges They Have Faced in Learning Statistics

	Student responses	Frequency	Percent
1	The difficulties of examples, equations and calculations	101	22%
2	Teachers and the teaching methods	93	20%
3	Not enough time	57	12%
4	Poor background and understanding	55	12%
5	English language and technical word	32	7%
6	How to apply the statistical concept (Project)	22	5%
7	How to pass the course (students' main aims)	18	4%
8	The use of technology	15	3%
9	New knowledge	12	3%
10	Not Interesting	10	2%
11	Other	38	8%

The fifth open-ended question that students were asked referred to what students would like to change about statistics courses for non-specialists in their university. The responses obtained in this question represent 40% of the total responses that could have been obtained from the students. The majority of the students' responses (22%) indicated that they want to make the statistics courses more relevant to their main subjects. Furthermore, 17% of students' responses would prefer to reduce the contents of statistics courses. Moreover, students discussed a need for more examples and opportunity to practice and apply the statistical concepts within the course. However, it is notable from students' responses that the first thing that students would like to change about statistics courses is reflected in factor three (The relevance of course), the fourth is related to factor one (The effectiveness of teacher), the fifth is related to factor five (Using technology) and the eighth reflected factor two (English language). *Table 4-40* presents the summary of students' responses.

Table 4-40 Frequencies of Students' Responses to What Non-specialist Students Would Like to Change About Statistics Courses

	Student responses	Frequency	Percent
1	Relevance of the course	184	22%
2	Reduce Contents	141	17%
3	More examples and practices	133	15%
4	Teachers and the teaching methods	90	11%
5	The use of technology	86	11%
6	More time and courses	57	6%
7	Remove the course from the study plan	29	3%
8	Use Arabic language	26	3%
9	Book	22	2%
10	Teacher should teach basic skills	13	1%
11	Final exam should be from the course not outside	10	1%
12	Other	51	6%

The first part of the last open-ended question that students were asked is whether the participants would like to take another statistics course. The participants were given three options: 'Yes', 'No' and 'Don't know' (*Table 4-41*). The majority of students (52%) do not want to study another statistics courses. 27% of participants want to study further statistics, where 20% of participants do not know.

Table 4-41 Frequencies of Students' Responses to the Desire of Students to Study Another Statistics Course

Student responses	Frequency	Percent
No	551	52%
Yes	289	27%
Do not know	213	20%

In the second part of the question, students are asked to give two reasons for their answers. The responses obtained in this part of question represent 47% of the total responses that should have been obtained from the students. 40% of responses from students who didn't want to take another statistics course indicated that the irrelevance of the statistics course to their main subject is their main concern. The difficulty of the statistics courses is considered to be the second most important reason. However, it is notable from students' responses that the first reason that makes students not want to take another statistics course is reflected in factor three (The relevance of course), the third is related to factor four (Students engagement), and the fifth is related to factor one (The effectiveness of teacher). *Table 4-42* presents the summary of students' responses.

On the other hand, the largest number of responses (27%) from students who answered 'Yes', indicated that they found that statistics is important in their future education or career, and considered this the most important reason in choosing to take another course. Furthermore, 24% and 18% of responses who wanted to take another statistics course indicated that this was because they had an interest in statistics and wanted to take their study of statistics further. However, it is notable from students' responses that the first and second reasons that make students want to take another statistics course is reflected in factor four (Students engagement), the fourth reason is related to factor three (The relevance of course), and the seventh is related to factor one (The effectiveness of teacher). *Table 4-42* presents the summary of students' responses.

Of students who answered 'Do not know' in their responses (30%) indicated that the irrelevance of statistics courses to their main subject as the main reason for their indecision. It is notable from students' responses that the first reason that makes students hesitant about whether they want to take another statistics course or not is related to factor three (The relevance of course), the second is related to factor one (The effectiveness of teacher), and the fourth and fifth are related to factor four (Students engagement). *Table 4-42* presents the summary of students' responses.

Table 4-42 Frequencies of Students' Responses to the Reasons of Students' Desire to Study another Statistics Course

	Student responses	Frequency	Percent
	No		
1	Irrelevant	207	40%
2	Difficult	107	20%
3	Not Interesting	78	15%
4	That is Enough	65	12%
5	Teacher and teaching methods	26	5%
6	Time	16	3%
7	Poor background	9	2%
8	Bad experience	7	1%
9	Many content	5	1%
10	Other	5	1%
	Yes		
1	Need for future	112	27%
2	Interesting	97	24%
3	Learn stat more	76	18%
4	Relevant	65	16%
5	Love math	25	6%
6	Easy course	19	4%
7	Teacher	12	3%
8	Other	7	2%
	Do not know		
1	Irrelevant	21	30%
2	Depend on teacher	8	12%
3	That is enough	7	10%
4	Interesting	7	10%
5	Not Interesting	7	10%
6	Time	5	7%
7	Other	13	19%

Chapter 5. Results of staff interviews

5.1. Introduction

This section describes the results of the qualitative analysis. The researcher used interviews to collect qualitative data. Sixteen teachers of statistics who teach statistics courses to non-specialist students in Saudi universities in Eastern Region were interviewed individually. The interviews lasted approximately between 20 to 35 minutes. The transcription of all audio-taped interviews was the first step in data analysis and was undertaken by the researcher. Then, the transcripts of interviews were content analysed on a question-by-question basis. The researcher used manual analysis to read and re-read the interview responses, identifying the common main themes.

At the beginning of the interviews, the researcher asked the teachers to provide a copy of the syllabus from statistics courses taught in their institutions. *Table 5-1* shows the summary of the contents of these courses. The curriculum information available in the course documents gave a useful overview of the content of the curriculum. However, as is common to many course and programme documents, the documents did not provide any information about how the topics were actually taught.

Fraser and Bosanquet (2006) studied academics' definitions of curriculum and although some academics recognised broader definitions of curriculum, often teachers considered curriculum to be the course content and structure. This limited view of the curriculum as equated with the course content often explains why many course documents provide the topics covered, but no detail of the teaching approach adopted or the underpinning values informing the ways in which the subject is taught. In this situation, the teacher is a key source of information about the teaching approach adopted, and the teacher is also a key influence upon the students' learning experience. Therefore, in this study it was important to explore the teachers' approaches to teaching statistics. This can be best extracted from the interviews with staff. What they provided in the interviews was a broader picture of their approach to teaching which is in itself informative, but it is interesting that they did not provide information about any specific strategies they used for teaching particular topics other than where specifically asked about (for example adopting the PCAI approach).

Table 5-1 The Syllabus of Statistics Courses

		Faisal / Education	Faisal / Business / Stat 1	Faisal / Business / Stat 2	Faisal / Engineering	Faisal / Computer Science	Faisal / Agricultural	Fahd / Industrial Management / Stat 1	Fahd / Industrial Management / Stat 2	Fahd / Engineering	Imam /Business / Stat 1	Imam / Business / Stat 2	Imam / Business / Stat 3	Imam / Computer science	Jubail Industrial College	Dammam / Engineering	Prince Mohammed
Descriptive statistics	Introduction to Statistics	X	X		X			X		X	X			X	X	X	
	Frequency distribution	X															
	Graphical displays	X	X				X	X			X			X	X	X	
	Types of data						X	X									X
	Measures of central tendency	X	X				X	X			X			X	X	X	X
	Measures of variability	X	X					X			X			X	X	X	X
	Measures of association	X						X			X				X		X
	Methods of data collection		X					X			X						
Probability theory	Probability theory			X	X		X			X		X		X	X	X	X
	Random variables (Discrete & Continuous)			X	X		X			X				X			
	Discrete Probability Distributions			X	X			X		X				X	X	X	X
	Continuous Probability Distributions			X	X			X		X				X	X	X	X
Formal statistics	Hypothesis tests	X		X					X	X		X				X	X
	Time Series		X						X				X				
	Sampling Distributions and Data Descriptions				X					X							
	Confidence Intervals							X	X	X							
	Sampling Error, Sampling Distribution of the Mean							X				X				X	
	Statistical Inference									X							
	Simple Linear Regression and Correlation								X	X							
	Maximum Likelihood and Least Squares methods of estimation															X	
	Analysis of Variance															X	
Applicati-ons	Applications of Probability & Statistics in Electrical Engineering				X					X							
	Apply some topics of statistics in business												X				
	Some topics in biostatistics												X				

While the table gives a general impression about what topics are covered, a more extensive discussion through interviews is required to explore more general issues of the curriculum (Aliaga et al. 2005).

5.2. Summary of staff responses question by question

By choosing to present the results question by question, there is inevitably some overlap in the responses to some of the questions. These overlaps indicate some of the areas that emerged to inform the themes in section 5.3.

Q1: What is your main subject?

Table 5-2 The main subject of Teachers

Teacher	Main subject
1	Measurement, Evaluation and Experiment Design
2	Statistics and Insurance
3	Electromagnetic and Electric Engineering
4	Electric Engineering
5	Mathematical Statistics
6	Girls Education and Instruction
7	Local Community Development
8	Applied Statistics
9	Mathematical Statistics
10	Mathematical Statistics
11	Mathematical Modelling
12	Statistics
13	Applied Mathematics
14	Applied Mathematics
15	Applied Mathematics
16	Mathematical Statistics

Sixteen teachers who were responsible for teaching statistics courses to non-specialist students in Saudi universities were interviewed individually. The first interview question asked teachers about their main subject. The main subject of seven teachers was statistics, for four teachers it was mathematics and five of them were from other subjects including measurement, engineering, education and community development (*Table 5-2*).

Q2: What is the highest qualification you have in Statistics? From where (university & country)?

Five teachers had PhDs and two had an MSc in statistics, while the other teachers studied statistics courses as a requirement during their Bachelors and Masters degrees.

Table 5-3 The Highest Qualification of Teachers in Statistics

Teacher	Qualification	University	Country
1	PhD	Michigan University	USA
2	PhD	Cairo University	Egypt
3	No Degree	-	-
4	No Degree	-	-
5	PhD	University of Suez Canal	Egypt
6	No Degree	-	-
7	No Degree	-	-
8	PhD	University of California	USA
9	MSc	University of Yarmuk	Jordan
10	MSc	University of Yarmuk	Jordan
11	No Degree	-	-
12	PhD	Cairo University	Egypt
13	No Degree	-	-
14	No Degree	-	-
15	No Degree	-	-
16	PhD	University of South Florida,	USA

Q3: For how long have you taught statistics to non-specialist students in this university?

Table 5-4 The Experience of Teachers in Teaching Statistics

Teacher	Experience	Teacher	Experience
1	25 years	9	14 years
2	4 years	10	10 years
3	2 years	11	18 months
4	1 year	12	11 years
5	8 years	13	1 year
6	4 years	14	12 years
7	4 years	15	4 years
8	20 years	16	7 years

Eight teachers had teaching experience between one to five years (three of them only one year). Also, three teachers had teaching experiences between six and ten years and the same number of teachers had teaching experiences between eleven and fifteen years. Only two teachers had more than twenty years experiences in teaching statistics (*Table 5-4*).

Q4: What are the main teaching methods you use in your statistics courses for non-specialist students?

The majority of teachers (12 teachers) indicated that lecturing was the main method used when teachers want to explain new statistical concepts. However, teachers use different approaches during the beginning of their lectures. Three teachers mentioned that they started with introducing the main concepts and topics of statistics in a simple way because as one teacher commented *"...students come to the course with no background about Statistics or data analysis."* (Teacher 9)

More specifically, three teachers indicated that they followed a teaching approach which starts with theoretical parts (lecturing and explanation) of the topic then proceeds into practical (exercises); while Teacher 14 reported the opposite of this approach where he: *"begin[s] by explaining the applied part of the topic…only then I can go over the theoretical part of the topic with ease. This teaching strategy is closer and more convenient for the student's perception, especially when studying new statistical concepts,"* (Teacher 14).

Four teachers mentioned that some exercises are given to students as group work in the class or as homework; also those teachers described using discussion with their students in the classroom during the lecture to make the atmosphere of learning more interactive and effective. Only two teachers indicated that specific textbooks are assigned to students to help the teachers in teaching statistics. Furthermore, assignments, reports, projects and quizzes were all considered as methods for teaching statistics by four teachers. As one respondent stated:

"I also request students to carry out research projects in small groups of two or three students, each working on one project …. In the end, we discuss these projects in the class, subject to time availability," (Teacher 15).

Despite the diversity in teaching methods and techniques that are used by teachers, there was one teacher who only used lecturing. Only two teachers' responses mentioned the importance of ensuring students realise the importance of statistics courses to their main subjects. For example, one respondent talked about how he:

"Demonstrate[s] the results of some statistical applications and past research related to the science of agriculture," (Teacher 7)

While another teacher said, *"I set out to show the students the objectives of the topic and its importance to their major subjects, followed by the presentation of some illustrations,"* (Teacher 15). While this issue has been taken into account by a few statistics teachers, the diversity of students' responses referring to teachers clarifying the importance of statistics courses before starting the course (Question 14) confirms that many respondents selected the 'Strongly Disagree and Disagree' option for this question (*Table 4-3*).

The use of technology is an important issue in teaching statistics with non-specialist students. One teacher commented, *"In general, the university encourages the use of technology in teaching, and I am one of the staunch supporters of this trend,"* (Teacher 16). The most frequently mentioned technology that was used to present statistical concepts in lectures is PowerPoint (8 teachers). Five teachers indicated that they used the whiteboard when they want to explain some topics or concepts during the lectures. Only one teacher (Teacher 15) mentioned about his use of a smart board and another teacher (Teacher 16) mentioned his used of a blackboard in teaching statistics.

Commenting on the more specific use of discipline specific technology in teaching statistics, only six of the sixteen interviewees indicated that some statistical software packages are used in teaching statistical concepts, three of them (Teacher 8, 9, and 10) who are in the same university mentioned that students are assigned weekly hours (one or two depending on students' main subjects) for computer lab practice to be able to apply what students learned in the lectures. Several teachers' comments regarding the use of statistical software programs illustrate these points:

"In general, I make sure that students can understand all essential statistical concepts and are capable of applying them through any statistical program, particularly the SPSS and Minitab." (Teacher 10). This view is consistent with students' responses in the same institution where this institution has the highest percentage (54%) of students who are satisfied with their ability to apply the statistical concepts in their main subjects, and the lowest percentage (20%) of dissatisfied students (*Table 4-25*).

Some teachers added some reasons for not using statistical programmes in teaching statistics, such as the availability of resources and time to support teaching. One teacher noted *"There should be computer labs, assistant lecturers to help out. So far, I am the only lecturer in my subject in the faculty,"* (Teacher 2). Another teacher cited that *"at the end of each semester I explain the SPSS program to the students in broad terms, due to the limited time of the course,"* (Teacher 11).

Q5: what assessment methods do you use in your Statistics courses for non-specialist students?

All teachers' responses indicated that homework, quizzes and midterm exams are used during the semester to assess students. In addition, all participants mentioned that there is a final exam at the end of the course. To ensure the students engage with the course throughout the semester, one teacher intended not to inform students about the exact time of the quiz:

"We inform them that there will be a "quiz" next week, without naming the day. In this way, students will be in touch with the subject throughout the semester," (Teacher 2).

Furthermore, projects are assigned to students as assessment methods by five teachers. Otherwise, one teacher highlighted the limitations they face in choosing appropriate assessment methods *"I do not follow a personalized method for the students' assessment. I only follow the College's assessment plan, which is applied in the Department,"* (Teacher 13).

Based on the interaction of students in the class, six teachers expressed how participation, discussion and activities with students in the class are taken into account in the assessment. This is typical of several of the teachers' comments:

"Class participation is mandatory, even if students make mistakes. The aim is to make them able to find out the error and correct it," (Teacher 2).

"Students must be challenged in order to make some efforts in the class. If they are not, the class will turn into a mere theoretical lecture. In that circumstance, the students' role will be passive in the lecture and they will get nothing out of it," (Teacher 12).

Four teachers' also drew attention to the importance of examining students' practical skills such as those in using statistical programs. Teacher 14 pointed out that: *"I see that students' performance should be assessed on the practical side in the computer lab as well, by assigning them research projects and requesting them to apply the statistical concepts they have learned ... Of course, this practical test must be part of the student's overall assessment,"*

This teacher argued that assessing students' abilities in using statistical programs is important for students' future employment: *"Students after graduation are expected to serve in companies and factories in the first place, and so it is of paramount importance to develop their capabilities in using software in Statistics and in applying statistical concepts,"* (Teacher 14). However, most of the assessment methods used by teachers are similar and are clear for students, so we can find that the majority of the students' were satisfied in their responses about clarifying assessment criteria at the beginning of the course (*Table 4-3*).

Q6: What are your main aims in teaching Statistics to non-specialist students?

The main aim for most of the teachers of statistics is to achieve the objectives of the statistics courses and explore its importance to non-specialist students. This seems to be particularly important given the lack of attention to the application of statistics in Arab countries in general as one teacher (non Saudi teacher) commented that: *"In the Arab world in general, this science is very much played down,"* (Teacher 16).

The importance of statistics was divided into two areas within teachers' responses; 1) the importance of statistics in the real life of students - as one respondent stated *"Relate statistics to daily life activities in order to make them realize the feasibility and importance of the subject,"* (Teacher 2) and 2) how students should take advantage of statistics in their main subject - as one respondent stated *"Try to link statistics to applied areas in the field of agriculture… this makes the student able to utilize statistics in his major subject,"* (Teacher 7). Moreover, the results of students' responses at this teacher's institution are compatible with the teacher's statement: 52% of students in this institution are satisfied with their ability to apply statistical concepts in their main subjects, and 16% of students are dissatisfied (*Table 4-26*).

One teacher in an engineering college indicated the importance of learning statistical concepts for helping students to gain a deeper understanding of their main subject. He reported that his aim is to make the students more familiar with probability as the students need it in engineering topics.

Another aim of some teachers is to enable students to be able to make decisions based on statistics. Two teachers mentioned that it is a useful situation for a student to be a successful decision-maker and to realize the important of statistics in their life. Teacher 5 indicated that: *"If the student is able to make a particular decision on a particular case in his personal life … he will realize that statistics is important to him."*

Another aim mentioned by several teachers was to fill the gaps in students' mathematics and statistics background knowledge. Many non-specialist students at university and sometimes at high school level (humanity and management path) stay away from mathematics for a long time and most of them are studying a statistics course for the first time at university.

The third aim mentioned by some teachers was to enhance the capability of non-specialist students to apply the theory and use statistical software programs. With the limitations in the use of technology in statistics courses and the limited availability of computer labs, only three teachers indicated this issue within their goals. Furthermore, the benefits of the use of technology are not limited to the ability to apply the theoretical part of the course, but it can also contribute to engaging non-specialist students in learning about statistics as Teacher 10 cited:

"I would like to point out that students find the applied part of the Statistics course … absolutely enjoyable when they deal with it in the lab. In contrast, the study of theories and laws of Mathematical Statistics is less enjoyable and fun for them."

Other respondents also mentioned the importance of ensuring statistics courses are more interesting and fun for students.

There are several individual aims that are mentioned by teachers. Since statistics has its own characteristics, three teachers indicated that making sure non-specialist students understand the language of statistics and are able to carry out some basic statistical processes are considered important aims for those teachers. Also, two teachers noted that their students are asked to prepare projects and they then give the students an opportunity to present their results and discuss them with their friends. Furthermore, one teacher aimed to show the students some previous projects and studies from real life.

Q7: How do these aims affect your teaching?

Seven teachers indicated that as the statistics courses are for non-specialist students from many different subjects, this forces them to design the course in a way that makes connections to students' main subject and that clarifies the importance of statistics to those students. As one teacher mentioned:

"The real effect lies in the careful selection and use of realistic examples relevant to the students' major subjects and interests," (Teacher 11). Nevertheless, students' responses about the relevance of the contents of statistics courses indicated that 40% of students are satisfied, while 34% of students are dissatisfied in this institution (

Table *4-23*).

One teacher pointed out that including relevant topics could help teachers to answer the frequent questions that students ask about why statistics is important for their subject. However, changing students' perceptions of statistics' importance may be not easy where students are studying statistics at the first level of university as one teacher stated:

"In this early stage of study, when I use some agrarian examples some students may fail to perceive them on account that they have not yet gone deep enough into their major subjects. To overcome this problem, I have to use generic examples that may not be pertinent," (Teacher 7).

The aims of the statistics course may affect the contents of the course. One teacher of statistics highlighted the difference between specialist and non-specialist students and the teacher confirmed that specialist students should focus more on advanced topics, theoretical parts and theoretical proofs, while gaining a deep knowledge of these areas is considered unnecessary for non-specialists.

To achieve the goals of statistics' application, one teacher expressed his opinion that the use of technology is important for non-specialist students:

"The most essential element in teaching Statistics is to use statistical programs, such as SPSS or Minitab. These programs enable the students to apply the theoretical part of the course, make the course enjoyable to them and facilitate their dealing with statistical operations," (Teacher 13).

However, one teacher's added that in applying statistical concepts, it is also important to make sure the data that are used in the computer lab are relevant to the major subject.

Sometimes students need to help each other during the writing of a statistical report, so one teacher indicated that the students are encouraged to work as group. Another teacher mentioned the importance of developing presentation skills. The teacher asked students to present their report after they reviewed it with their teacher as that can increase interaction among students.

Q8. In your opinion, what have been the most important developments in Statistics in the past twenty years?

With the growing development of statistics as an independent discipline, many parts of statistics have changed over the years. Ten teachers mentioned that the availability of statistical software packages is considered the most important evolution in statistics. One of them described how statistics was twenty years ago when the teacher was doing his Master degree and how the situation has now changed for the better. The data analysis used to be undertaken manually because the statistical programs had not been developed.

Some benefits of using statistical programs were mentioned by respondents and include the time saved and the error rate reduced compared to using manual analysis. However, one teacher pointed out that when non-statisticians use these programs, many of the analysis results are inaccurate where the students do not have enough knowledge or experience. Also, one teacher indicated that the interactive environment between teacher and students can be enhanced by using statistical programs and that using technology can reduce the time needed to teach and lower costs. This view was challenged by other results that suggest teachers need more time not less for enhancing interaction and covering all the topics of the course. However, this teacher confirmed that taking advantage of these benefits depends on the academics' institution regardless of the country.

Two teachers' responses indicated that one of the most important developments in statistics is that the applications of statistics have become more widely used in everyday life than before and that this might enhance the attitude of many people towards statistics. As one interviewee stated:

"Despite that social measurement is one of the oldest sciences in the Arab world; it is much neglected and looked upon as a foregone conclusion that has meagre value, since it has not witnessed development. However, with the introduction of Statistics and the implementation of statistical tests, this field would have much worth and weight for the students," (Teacher 7).

One teacher also suggested that currently some new disciplines depend largely on statistics, such as Actuarial Science.

Unfortunately, one teacher indicated that there is huge gap in the development of statistics between the West and the Arab countries and it may take a long time to bridge this gap in statistics teaching in Arab countries. As Teacher 10 noted:

"The companies here that need the efforts and experience of statisticians most do not duly have the orientation to expand their benefit from statistics, as is the case in Western companies. Unfortunately, this is typically the current situation in Saudi Arabia and Jordan, and perhaps throughout the Arab world,". Such a comment gives the impression that this institution is concerned to give more attention to the use of technology, and this is consistent with the results of the students' responses from this institution: students from this institution also had the highest rate of satisfaction with the uses of technology in statistics (see section 4.3.2. Using Technology).

In terms of branches of statistics, two teachers' responses mentioned that currently data mining and biostatistics are considered new branches in the statistics discipline. Also, one teacher referred to the great development in data collection methods as another evolution in statistics. On the other hand, the situation of non- specialist staff toward the development of statistics is an important point that emerged from the staff interviews. Two of the non-statistics teachers indicated that they have no idea about the development of statistics in past years and one of them reported that statistics is used only to assist in their main subject. Conversely, one non-statistics teacher referred to the International Conference on Teaching Statistics (ICOTS) and how it was very useful to keep pace with the developments especially for non-statisticians. One statistics teacher indicated that the topics within the statistics course which was taught to non-specialist students in his discipline has not changed since thirty years ago:

"The course mainly concentrates on some outdated statistical terms, and I do not know specifically the most recent topics they should be learning and using now," (Teacher 16).

Q8.A: How have the statistics courses in your university changed to reflect these developments?

Five teachers' responses mentioned that the availability of computer labs and incorporating the statistical programs into the course were the main changes. All of them emphasised the importance of the use of statistical programs for non-specialist students that has become necessary. However, another teacher argued that there is no benefit from statistics software programs for undergraduate non-specialist students:

"Students in the undergraduate level will not benefit a lot from those advanced programs, while the intended aims at this level is to teach them principles of statistics and its pivotal role," (Teacher 12).

In addition, another teacher pointed out that in his experience, the use of statistical programs and its applications is very rare among teachers and students. The teacher considered that there were few qualified people with the ability to use the statistical programs. Therefore, the teacher suggested that statisticians in collaboration with specialized institutions should provide some training courses for non-statistics teachers to improve their skills, then these teachers would be able to teach their students how to use the software programs.

Two teachers' responses indicated that the statistics courses in their universities have not changed, but the teaching methods that are used have changed. Where one of them described how he mainly relied on lecturing and a whiteboard twenty years ago when there was no computer lab, now, with the availability of statistical programs the teaching situation is different and the course has become more enjoyable.

A range of views were raised including that statistics teachers can have a direct impact on the development of the course where the teachers keep pace with the developments in the field; there had been no development in the course; the course had developed based on the requirements of the academic departments the non-specialist students come from; and new statistics courses and plans based on departments' requirements were in the process of being developed.

Five teachers' responses mentioned the limitations of the statistics courses and the time allotted that prevented development of the courses. Most of them suggested increasing the number of hours allotted to the courses, while one teacher from engineering had requested the separation of two courses - one for statistics and the other for probability - as engineering students need to study more about probability. Another teacher added that the lack of teacher assistants to help the lecturer may prevent the development of the course. This corresponds with the results of students. Despite the disparity of students' responses about issues of technology, a high percentage of students in all universities were dissatisfied with the lack of time that had been allocated to learning using technology including statistical software programs (*Table 4-14*).

One teacher noted that the developments were not interesting to non-specialists where those students study limited topics and courses in statistics, but were of interest to specialist students only. As one respondent commented: *"The main problem we encounter is students' disinterest in the study of Statistics. As you know, the university has BA and Masters programmes in Statistics. Yet, the number of students registered in these two programmes is zero. There is a strong aversion among students to Statistics,"* (Teacher 9).

Q8.B: When would the course be reviewed?

All teachers' responses except two teachers from the same university indicated that the statistics courses are evaluated regularly at the end of each semester by students. One teacher mentioned that the college follows direct and indirect ways to evaluate the course. The following comment illustrates one teacher's description of their evaluation approach:

"Students also evaluate the course outputs a week before the final exam. When we build up the contents of the course, we define its outputs and aims. As such, students realize from the outset the intended outputs and aims of the course, and we ask them for their opinions on what they have studied so far. Then, we compare their opinions against the final exam grades of the course. We call this assessment 'indirect assessment', where the 'direct assessment' is reflected in the students' final exam grades," (Teacher 3).

Furthermore, several teachers were asked by special committee to write a report about the course to identify the strengths and weaknesses.

One teacher's response indicated that although the modification of the course may take a long time, the course was reviewed constantly. In addition, two teachers noted that any change in the course was mainly based on the academic departments' requisites and what the departments needed from statistics rather than being based on students' needs. However, one teacher mentioned that the staff in his department had different opinions about the skills that are covered by the course. Some staff believe that practical skills are more important for non-specialist students and these skills should be emphasised more within the course, while other staff emphasised the theoretical parts of the course.

Only three teachers' responses, who were from same university, indicated that the statistics book which is assigned to students is reviewed every four years to ensure its suitability and readability and that the book covers what students need. The concerns of teachers in this institution about evaluating statistics courses are consistent with the students' results, where students from the same institution have the highest percentages (62%) of students who are satisfied with the relevance of their statistics courses to their main subjects, and the lowest percentage of dissatisfied students (

Table *4-23*).

Despite the continuous evaluation of the statistics courses in universities to keep pace with the development, two teachers argued that statistics courses for non-specialists were limited in terms of their possibilities for development, as Teacher 16 commented:

"*This course is primary in many universities around the world. So, I cannot make any changes to it, whether in the content or the syllabus, which is nearly the same in most universities. However, we review the course with the aim of developing it, making it up-to-date with its counterparts in the world universities*,"

In contrast, two teachers' responses, who are from same university, indicated that the course had not changed for more than twenty years although they have heard the course would be evaluated soon. However, students' responses from this institution indicated that 43% of students are satisfied with the relevance of their statistics courses to their main subjects, while 34% of students were dissatisfied (

Table *4-23*). This percentage of satisfied students may confirm the previous idea mentioned by Teacher 16 that suggested the contents of introductory statistics courses are limited.

Q9: Do you introduce the PCAI[1] framework to non-specialist students? If YES, how useful do you find the PCAI approach?

All teachers' responses indicated that the idea of the PCAI framework had been introduced to non-specialist students during the course. However, most of them noted that the students had not had the opportunity to carry out the PCAI step of 'data collection', due to time constraints and to large numbers of students enrolled on the course. One teacher from a college which teaches two statistics courses pointed out that the framework was not applicable with the first course, but it was applied within the second statistical course.

All teachers argued that providing the framework to non-specialist students had many benefits. The teachers' responses listed several positive points of the framework, for instance increasing the students' ability to analyse data and interpret the results. Teacher 8 described his attempts to improve students' abilities:

"I ask the students to analyse the data and focus on a salient question: What is the significance of the results I have obtained? Their interpretation of the results must be feasibly and closely related to the operation the student has carried out,"

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[1] PCAI framework include four components: Pose the question, Collect the data, Analyse the data and Interpret the results.

Furthermore, through the steps of the framework, student views about the importance and usefulness of statistics becomes clearer for non-specialist students. Another teacher argued the framework had further benefits:

"This moves them from the relatively uninteresting theoretical side to the more engaging application of the theory, which helps to raise their attention, enthusiasm and interaction during the lecture," (Teacher 13). However, the student results from this institution contradicted this teacher's response as this institution has the second highest percentage (42%) of students who are dissatisfied with interactive exercises used by teachers (*Table 4-21*).

One teacher noted that his students did not ask to apply all steps of the framework during the statistics course, therefore he could not judge whether the framework was useful for non-specialist students or not.

Q10.A: Do you use technology in teaching statistics to non-specialist students? If yes, can you tell me a bit about how you use technology in your teaching?

All teachers except for two teachers indicated that they had used technology in teaching statistics. As mentioned in the answers to Q4, the majority of teachers noted that they used PowerPoint as a tool to present their lectures. While, only one teacher used a smart board and one teacher used a blackboard for teaching statistics.

Another use of technology is as a resource in learning statistics for both teachers and students. Most of teachers reported that the internet is used as a reference to assist students to learn statistics, and more specifically two teachers referred their students to YouTube to learn about statistical concepts, one teacher referred to Wikipedia and one teacher encouraged the postgraduate students to use academic journals online.

All teachers' responses except three indicated that statistical software programs were used to analyse the data and apply the statistical concepts that were learned in lectures. Excel, Stata, SPSS and Minitab were the most popular programs mentioned by teachers. Only two teachers' suggested that the statistical package used depends on the main disciplinary subject of the students:

"The Matlab... is often used due to our heavy reliance on it as engineers," (Teacher 4).

"STATISTICA, is used with Engineering students, and other one, "Minitab", is used with the Administration students," (Teacher 8).

Furthermore, the use of technology can have additional benefits in teaching statistics as Teacher 11 noted that: *"technological facilities, such as using computer and statistical programs ... help to save time and free the teacher up to concentrate on explaining the important statistical concepts to the students,"*

With the widespread use of technology among teachers at various levels, there were only two teachers that mentioned that technology was not used in the statistics teaching. One of them noted that the main reason was the large number of students in the classroom which can exceed 100 students. Another indicated that technology facilities were not available in the college, but the administration of the college had began to set up a computer lab and so statistical programs would be available in the future. Students' results from these two institutions are compatible with the lack of technology use in learning and teaching statistics, where students' responses indicated that 74% and 85% of students respectively were dissatisfied with the technology used by teachers (*Table 4-15*).

Q10.B: In your experience, what are the main challenges to using technology in Statistics courses?

Teachers' responses divided into three main challenges of using technology: staff, students and facilities. First, several issues regarding staff were raised including 1) the diverse burdens on teachers that include a heavy teaching load that is considered one of the most important difficulties; 2) the lack of staff, whether assistants who help the lecturer to apply the theory parts of the course, or technical staff who manage the technical support of the practical laboratories was one of the difficulties; 3) there was a lack of staff who had a really good statistical background; 4) the unwillingness of senior staff to use technology and their lack of experience with statistical software programs. It was also considered by some respondents to be the responsibility of students to learn and teach themselves the use of statistical programs leaving the teachers to focus on teaching them the main statistical concepts. On the other hand, two teachers mentioned that the difficulty lies in how to convince students of the importance of statistics in relation to their main subjects. Teacher 12 commented: *"There is a lack of cooperation among the lecturers in the department in emphasizing the importance of Statistics course. This generates a disinterest among students in it on the grounds that it plays no significant role in their major subject,"*

Some of the challenges of using technology were caused by the large number of students in the class. As mentioned in the previous question, two teachers noted that the large number of students in the classroom prevented the teachers using technology. One teacher confirmed that frequent absences of students was considered one of the most important difficulties while the teacher also pointed out the weak criteria used for accepting students at the college:

"There are students in the department of Business Administration who are too weak to study Statistics, let alone being students in the department in general," (Teacher 12).

Furthermore, several issues were raised including 1) the computer skills of students in some disciplines are poor, though another teacher pointed out that the current generations of students are more fortunate than previous generations because they have greater technical skills; 2) the teachers faced some difficulties with non-specialist students who had to use statistical software programs for the first time; 3) the low level of English language ability was considered a major difficulty facing the teacher when students use statistical software programs.

Finally, five teachers responses indicated that the lack of technical facilities, internet availability and computer lab capacities were the biggest challenges faced by teachers in the use of technology. Another teacher noted that his university was doing its best to provide the latest versions of the software programs as the teacher commented:

"I believe that we in the Arab world sometimes make exaggerations about failing to keep pace with latest developments in technology. Once I was on a visit to London to present a paper in my area of specialization. I was surprised to see that the software version I was using in my presentation was newer than the one other presenters from London were using. Perhaps, this is not surprising in the Gulf region, given the state of affluence and prosperity," (Teacher 7).

Q11: How can the limited English language skills of some Saudi students affect their learning of Statistics?

Teachers' responses indicated that English language caused several difficulties for students. One of them is that the technical words used in the study of statistics do not have equivalent translations in the Arabic language, so the teacher is forced to use English terminology. Furthermore, the lack of reading resources for statistics where the translation of statistics books from English is rare prevents students keeping pace with the development of statistics. In addition, students find it difficult to read statistics textbooks in English. Moreover, the final results of the course were affected negatively by students' poor grasp of English language:

"I often find in exams that the most common errors in the answer sheet result from students' incorrect understanding of the questions, which affects their final results. The students themselves admit that their level in the English language is not good enough to understand the exam questions," (Teacher 7).

"Most students who fail the course do not understand the meaning of these statistical terms," (Teacher 16).

Two teachers suggested some ways to overcome these difficulties. One teacher noted that he asked his students to pay attention to the key words in the questions of the exams as a way to help the students to understand the question, although the teacher was not satisfied that this was a complete solution to this problem. While another teacher who taught the course in Arabic indicated that after introducing the statistical technical words the teachers should write their English equivalent for the terms to help students' understanding.

Three teachers pointed out that statistics requires students to have a slightly better grasp of English where the characteristics of the statistics discipline are not the same as mathematics. Mathematics is based on symbols and figures, whilst statistics requires skills in English language to understand its concepts and application. The following comments illustrate these points:

"...questions in Statistics are not posed in the same way as those in Applied Mathematics or Pure Mathematics. Questions in Statistics are phrased in prose form in order to describe a real situation and explain a certain problem," (Teacher 11).

"In Mathematics, even if the student's English skills are not good enough, he still can study it, since it mainly relies on the use of symbols and figures. In contrast, Statistics requires the students to have a good command of the English language," (Teacher 13).

On the other hand, nine teachers' responses mentioned that there was no effect from English language on learning statistics. One teacher indicated that all courses in his university were completely taught in English, so there was no effect from English language on learning statistics where students' English language abilities were good. The students' results confirm that students from the universities that use English as the main language of instruction (King Fahd, Prince Mohammad and Jubail universities) were more satisfied with English language issues compare to students' responses from other universities (*Table 4-7*). However, a teacher from another university where English was the main language in this institution mentioned that he thought that in teaching statistics sometimes students' understanding of statistics is better when they learn statistics in Arabic than when they learn statistics in English, as English can be a stumbling block to students' learning. Finally another teacher who teaches a statistics course in Arabic commented that: *"It has no influence at all, because there is no Statistics in English and Statistics in Arabic. We only use simple terms in teaching Statistics,"* (Teacher 12).

Q12: What are the most important challenges you have faced in teaching Statistics to non-specialist students?

The teachers interviewed identified three main categories of challenges, which are courses, students and facilities. Firstly, four teachers' responses indicated that non-specialist students need some mathematics skills to be able to study statistics courses, and most of the students were struggling with mathematics: *"The most important challenge is that nearly 40% of the students come from high schools with a weak background in Mathematics,"* (Teacher 7)

Also, one teacher noted the majority of students who study the course the first time have no statistical background at all. Another teacher found that some topics of statistics such as probabilities and analysis are particularly difficult for non-specialist students. Three teachers also noted that the time scheduled for statistics courses is not enough to cover the course content.

To overcome students' lack of mathematics and statistics knowledge, four teachers pointed out that the first two lectures were devoted to reviewing their basic mathematical background. Also, the teachers who suffer from shortness of time allocated to statistics courses indicated they were asking the college administrators to increase the allocation of time for statistics courses and they were limiting their teaching to the most important statistics topics.

Three teachers' responses indicated that the English language ability of non-specialist students is low and this has caused difficulties in teaching statistics. Other teachers added that the variety of students' academic level had also caused several difficulties. Some of students in the classroom were excited to study statistics and wished to do so, while others did not want to study statistics, so it is not easy for the teachers to meet the needs of all students. In addition, six teachers indicated that the main challenge was the reluctance of students to study statistics where the students believe that statistics is not important for them and is not relevant to their main subject as one teacher stated:

"The most important challenge in my view is the students' lack of conviction of the importance of Statistics to their major subjects. They take the Statistics course only because it is mandatory in the study plan," (Teacher 10).

Another teacher commented,

"The first and most significant challenge is represented in the recurring question I receive from students: What is the importance of Statistics to our major subject?" (Teacher 15).

Also, one difficulty mentioned by two teachers was that students enquired about proofs for some statistical theories, but the teachers were keen not to go into more details about these more difficult concepts in order not to make the course too complicated. One teacher described the continued absence of students in his department as the main challenge in teaching statistics.

The teachers' interview responses mentioned some suggestions to deal with these difficulties such as the use of Arabic language in statistics courses which are currently taught in English to help explain the new statistical words and concepts for students. One teacher found that students who spent time studying hard in the preparatory year strengthened their English language skills. Also, another teacher indicated that teaching the students using simple methods, assigning some homework and encouraging their participation in the class may contribute to enhancing students' academic level. In addition, to correct the misconception about statistics not being relevant to their main subject of study, four teachers mentioned that they used relevant examples for students' main subject of study and applied the statistical concepts in statistical programs as useful ways to change students' beliefs. One teacher also suggested that deducting students' marks and setting a limited allowance for absence from class may prevent them disengaging from lectures and the course.

Finally, only one teacher's response indicated a lack of technology facilities as a difficultly in teaching statistics. Only one teacher also considered that there were no challenges in teaching statistics to non-specialist students at all, because their students all enjoyed the course.

Q13: If you could make some suggestions about teaching Statistics to non-specialist students at your own university, what changes would you suggest making?

Nine teachers' responses mentioned that the scheduled time of statistics courses was not enough, therefore those teachers have emphasized the need to increase the number of hours for statistics at their university. Also, four teachers noted the importance of the availability of computer labs and using technology to apply the statistical concepts. Furthermore, two teachers indicated that all students who get an offer to study at the department must be able to demonstrate they can meet the main criteria as this can help them to continue their studies successfully. Another two teachers pointed out that decreasing the number of students in the class is one of the things that the teachers want to change.

A variety of suggestions have emerged from the teachers' interview responses. One of these suggestions is including some basic mathematical topics at the beginning of statistics courses to refresh students' background. Also, one teacher mentioned that in order to provide students with some of the basics of statistics, it is useful to teach them some statistical subjects at the high school level. One suggestion noted by one teacher was that the statistics course at his department should be reviewed as the course had not been evaluated for more than twenty years. The following teacher's comment suggests more focus needs to be spent on course design for effective statistics courses:

"I would make sure that the course covers all the essential topics students need to learn. Also, the course syllabus must be reorganized based on the sequence of the topics in the textbook," (Teacher 13).

Also, another teacher mentioned his enthusiasm to apply the PCAI framework (Pose a question, Collect the data, Analyse the data and Interpret the results) because he believed it to be a very important tool for non-specialist students. While one teacher noted his desire to exchange the timing of the statistics course within the department's study plan from the first semester to the third semester. Another teacher indicated the need to increase the awareness of statistics and its importance among people. Interestingly, one teacher mentioned that currently the college is setting up a unit that assists people in this college with data analysis and interpret the results of data.

Q14: Do you have any experience of teaching statistics courses offered anywhere else in the world? If Yes, where? How long?

If respondents had taught statistics outside Saudi Arabia, they were also asked what the biggest difference was between the international experience and that of teaching statistics in Saudi Arabia. The following table summarizes teachers' interview responses.

Teacher	Where	Year	Different experience
1	Saudi	15	Previous generations were better. Females are better than males
2	Egypt	16	Huge number of students in class in Egypt (3000 student) then divided to sections ranging 80-100 students for tutorial – no different in general.
3	Jordan	2	Same problem with low level of English language – in Jordan, students have strong foundation from high school especially in statistics.
4	Jordan	5	In Jordan, students have good English language level – number of students in Jordan 60 but in these department 5-10 students (new college).
5	Egypt	7	In Egypt, female with male at same class – girls in Saudi have higher level than Egyptian – the life more difficult in Egypt than Saudi which affects the academic achievement.
6	No		
7	Egypt	4	In Egypt, students come with high level in high school – more than one statistical course in Egypt - No significant difference.
8	No		
9	Palestine & Jordan	2 & 2	Different in economic situation and its impact on education.
10	No		
11	Saudi	4	No different
12	Egypt	18	Awareness of the importance of the main course of students in Egypt more than Saudi.
13	UK	1	Big difference – more statistics application in UK – the availabilities of specialists.
14	Saudi	6	No different
15	Jordan	1	Quality of high school student is higher in Jordan - teachers' commitment – students' inquire more in Jordan.
16	US & UAE	3 & 8	US students more diligent – social life different and effects student study.

The quality of students from high school, their English language ability and the impact of difficult economic living conditions are the most common differences in the situation of teaching statistics between Saudi Arabia and other countries, especially with other Arab countries. While one teacher who had experience teaching statistics in the UK indicated that the extensive use of statistical applications in UK is the most important difference. This teacher commented that:

"The difference between teaching here and there is a long story. But, one significant difference is that in Britain, teaching and learning immensely rely on application. Application is indispensable to the theoretical part. Also, the use of technology and the availability of qualified specialists who are capable of training others help a lot in promoting the praxis," (Teacher 13).

Another teacher indicated the motivation of students to learn statistics differ in different countries as described in his comment:

"Once I gave my students there an assignment and I totally forgot to follow up with them. I was surprised that nearly all of them submitted their assignments without a follow-up, and only very few fell behind in their submission. Arab students, in contrast, are less diligent and evade making any effort as much as they can … this does not happen with students in the West," (Teacher 16).

5.3. Themes

Eight themes emerged from the statistics teachers' responses: (1) the lack of students' motivation to learn statistics; (2) students' participation; (3) students' assessment; (4) the effective use of technology; (5) The previous maths and statistics level of non-specialist students; (6) The English language ability of non-specialist students; (7) the need for extra time for teaching and learning statistics; and (8) the role of administrators.

5.3.1. The lack of students' motivation to learn statistics

The majority of teachers' responses indicated that the lack of non-specialist students' motivation to learn statistics was considered one of the most important factors in teaching and learning statistics and had the potential to adversely affect the students' benefit from statistics courses. One of the most important reasons for this was the non-specialist students' belief that they are not statisticians and statistics is not relevant to their main subjects. One teacher described the viewpoint of non-specialist students toward statistics courses as *"I have taught postgraduate students in the Faculties of Dentistry, Medicine and Veterinary, and I noticed that they do not give the topic much attention because it is not their major, in spite that analysis is of paramount importance to their Ph.D,"* (Teacher 5).

Therefore, most teachers of statistics mentioned that the teachers strived to make statistics courses more closely related to the diverse disciplines of non-specialist students through the use of related examples. This connection may help students to know the answer of their frequent question which is 'why do we learn statistics?' Furthermore, this linking may help students to understand that the importance of statistics is not limited to their specialization but includes real life as well.

Moreover, most teachers mentioned that making statistics courses more interesting and enjoyable helps to increase students' desire to learn statistics. The use of technology such as PowerPoint to present the lectures, as was the case with most of the teachers, was one of the ways to reach this goal, as was the inclusion of students in more interactive teaching methods (see theme 2 in 5.3.2), and the use of statistical packages to enable students to apply the statistical concepts in practice (see theme 4 in 5.3.4). Furthermore, the majority of teachers' responses indicated that the use of PCAI framework with students illustrated the importance of statistics to students' main subjects and that helped to motivate students to learn statistics.

On the other hand, the lack of students' motivation to learn statistics is not limited to non-specialist students but includes the reluctance of high school students to study a degree in statistics. Undoubtedly, the failure of students to understand the importance of statistics may affect the country's need for statisticians, as can be seen in this study where 81% of the participating teachers who teach statistics are not from Saudi Arabia.

5.3.2. Students' participation

The teachers' responses referred to the role of students' participation in the class and how it is necessary to have an interactive atmosphere. The majority of teachers indicated that students' participation and growth in the students' collaboration with each other could increase their interest to study the course. Student-centred learning suggests that students play an essential part in learning statistics in the class and their learning benefits from not just listening to the lecturer. Students' participation depends mainly on the learning activities that are used by teachers such as discussions and assigning students some research projects and then presenting the results to their peers in the class to encourage further discussion. Also, most of the teachers indicated the importance of homework for the continued involvement of students. Some of the teachers encourage their students to do homework on their own and some of them encourage students to work within groups which may support more interaction and participation.

5.3.3. Students' assessment

The teachers' responses clarified that the practical part of the statistics course is not less important than the theoretical part but these two elements are complementary. Where the students learn and understand the theoretical statistical concepts, through the practical part students can apply those concepts using the statistical software programs. Therefore, some teachers confirmed that the assessment of student learning should not be limited to assessing the theoretical elements only, but it should include assessment of the practical elements as well, where both are important for students' future careers. Introducing practical assessments would make students realize the importance of the practical side of statistics courses and enable them to demonstrate their skills that are needed for future employment.

5.3.4. The use of technology

The majority of teachers pointed out that the use of technology whether in presentations or in analysis was considered an important tool for learning and teaching statistics. In presentations, the teachers indicated that the use of technology increased the enthusiasm among students in the class. Furthermore, the statistical programs helped students to apply what they had learned and students seemed to find this enjoyable. Some teachers mentioned that the use of statistical programs was not considered an obstacle for their students; especially with students who are studying scientific disciplines since those students are using other programs for other disciplines. Students who were studying at the universities using English language as the main language of instruction, did not find any difficulties in using statistical programs. Therefore, the teachers believed that these students had sufficient experience to use any statistical program without any problems. Some teachers highlighted the current high level of development in technology compared to previously, and they suggested that this provides an opportunity for students to develop a variety of skills in the use of technology where there is support for the students to use statistical programs.

On the other hand, some teachers believed that in spite of the importance of statistical software programs for their students, it is not easy to use these programs and integrate them within basic statistics courses. The viewpoint of these teachers was that non-specialist students in early stages of learning statistics need to learn about basic statistical concepts rather than the use of these programs, particularly where time is limited (see theme 7 at 5.3.7). In addition, students with poor English language ability found that the use of these programs was an obstacle especially when students used the programs for the first time.

5.3.5. The level of previous maths and statistics of non-specialist students

The majority of teachers mentioned that the mathematical and statistical background of non-specialist students is insufficient. Some teachers pointed out that the levels of students' background knowledge in mathematics and statistics did not meet the requirements of their disciplines and these students need to learn more maths skills. However, some teachers mentioned that teaching the students some basic statistical concepts in high school would be very helpful and would support them to have sufficient background and to learn statistics.

For students who specialize in humanities, they are away for long time from the study of mathematics and this was thought to cause some difficulties for these students in studying statistics courses. Some teachers indicated that it was not easy to deal with this gap. The allocation of the first lectures to review the mathematical topics with students was considered to be one of the solutions followed by some teachers to fill the gap and to overcome this difficulty. Yet this was considered time consuming where time constraints have been raised as a concern by several respondents (see theme 7 at 5.3.7).

5.3.6. The English language ability of non-specialist students

Teachers' responses pointed to the low levels of English language ability demonstrated by students at universities that are not using English language as the main language of instruction. Those teachers mentioned that the English language was an important factor that might hinder students to access and take advantage of the statistics references and resources in English, where there was a lack of references in Arabic. Furthermore, some teachers indicated that the weakness of English language background might also affect the ability of students to use statistical software programs since these programs rely on English language.

This led some teachers to suggest that an increase in the required admission criteria for university entrance was important especially for some academic departments. Students who did not reach the required criteria would be not able to study some courses in their disciplines including statistics courses where these courses require a certain level of skills.

5.3.7. The need for extra time

The majority of teachers' responses indicated the need to increase the scheduled time for teaching statistics courses. One of the reasons is that statistics is a brand new area of knowledge for most non-specialist students and these students need longer in order to establish good sound background knowledge of statistics. Also, most teachers' responses indicated that the scheduled time was not commensurate with the required contents of statistics courses. Therefore, some teachers felt the need to add more time for statistics courses to the study plan for some academic departments, which would enable them to choose more appropriate content and topics that students need for effective practice in their disciplines.

Another concern was the need for additional time to train students how to use statistical programs, especially when the number of students in the class is high and those students use the programs for the first time.

5.3.8. The constraints of administrators

One of the most important issues that arose from teachers' interviews was the impact of universities' management systems and structures on teaching statistics for non-specialist students in Saudi Arabia. Some teachers' responses indicated that they followed the aims, teaching and assessment methods that are specified by the college administration for teaching statistics courses and the teachers are obligated to use these methods. As Teacher 13 noted *"My aim is to deliver the intended aims of the course as set by the Curricula Committee ... I am only allowed to express my opinion and make recommendations about the teaching the course,"*

Most teachers mentioned that the design of statistics courses, the evaluation of these courses and any modifications are under the power of special committees while the responsibility of teachers is solely to provide the committees with reports of their implementation of these courses along with teachers' comments. Moreover, the majority of teachers pointed out that the availability of educational facilities at universities that are needed for learning and teaching statistics such as a sufficient number of computer labs, the internet, statistical books and installing statistical programs on the computers is also the responsibility of university administrators as well. This is a crucial point as this situation limits the ability of individual teachers to enhance and improve the current teaching approaches, curriculum design and overall student learning experience for non-specialist students studying statistics in Saudi Arabia.

Chapter 6. Discussion

6.1. Introduction

The purpose of this research was to generate new knowledge by investigating how statistics courses are currently taught to non-specialist students in Saudi universities. This study utilised two data collection tools to answer these research questions. Firstly, questionnaires were completed by 1053 non-specialist students in six different Saudi universities who had completed at least one course in statistics. Exploratory data analysis was used to analyse the first section, which comprised closed questions that measured how statistics courses are currently taught. Based on the literature review, five main groups of questions appeared: 1) Effectiveness of Teachers; 2) English Language; 3) Relevance of Course; 4) Student Engagement; and 5) Using Technology. Then multilevel modelling and factor analysis were conducted. Students' responses to the open-ended questions in the second section were combined, grouped and analysed. Secondly, interviews were undertaken with 16 teachers of statistics in the same Saudi universities. These interviews were analysed and eight themes emerged from teachers' responses: 1) the lack of students' motivation to learn statistics; (2) students' participation; (3) students' assessment; (4) the effective use of technology; (5) the previous mathematics and statistics level of non-specialist students; (6) the English language ability of non-specialist students; (7) the need for extra time for teaching and learning statistics; and (8) the role of administrators.

Drawing together the findings from the exploratory data analysis, from the open ended student responses and from the eight themes arising from the staff interviews, there are some key issues that emerge and which form the basis of this chapter. The discussion is organised and presented around these key issues: mathematics level of non-specialist students; students' engagement; the relevance of statistics courses; the implications of teachers and their teaching approaches; the implications of technology on learning and teaching statistics; and the implications of English language on learning and teaching statistics.

6.2. Mathematics level of non-specialist students

The sample of participants in this study included students in different disciplines, which helped to create a broader picture of non-specialist students learning statistics in Saudi universities. Related to the diversity of students' main subjects and their study streams at high school level, the results of staff interviews in the current study indicated a generally low level of mathematics ability among students, particularly those who came from the Humanities stream in high school and who therefore had not studied mathematics for a long time. One teacher described the situation of these students: *"Challenges may become greater with students who have not studied mathematics for a long time; ... There is a considerable number of such students in the Faculty of Arts. Some of them cannot sometimes perform the simplest operations in mathematics, such as adding a half to a quarter,"* (Teacher 5). This weakness was also found in students from the Scientific and Management stream and in some colleges even where these students study mathematics in high school. One teacher in the College of Engineering also highlighted the weakness of students in mathematics, even students who had completed the preparatory year, stating *"I know some students who got an A in Calculus in the preparatory year, but when they came to study in the College of Engineering they failed all the Mathematics modules. How strange! Had it been an individual case, there would not have been a problem, but, nearly 25% of the students fail consistently in various Mathematics course,"* (Teacher 15). However, this contrasted with the situation in other colleges, where the statistics teachers claimed that their students had a high level of mathematics skills and that these students found learning statistics enjoyable.

From the students' perspective, their questionnaire responses showed that weakness in mathematics causes students fear and anxiety in terms of calculations and dealing with numbers. The results indicated that difficulty with equations and calculations is the fourth most important factor hindering participants' learning of statistics (*Table 4-37*). In addition, the students pointed out that the most important challenge they face when learning statistics is the difficulty level of examples, equations and calculations, and this is related to the students' fourth most important challenge faced, which is their mathematics ability (*Table 4-39*). This result confirms that of a previous study conducted by Bradstreet (1996), which found that a low mathematics level may lead students to feel anxiety in dealing with numbers. However, the diversity of students will always mean there is some contradictory data, as can be seen in the teachers' interviews where some teachers indicated that there are non-specialist students with a high level of mathematics in some colleges. Similarly, the results of the students' questionnaire revealed that the fifth reason for students to study statistics is their love of mathematics (*Table 4-42*). This however suggests a challenging teaching environment where teachers have to teach statistics to students with varying abilities in maths.

In the interviews, several teachers mentioned that some basic statistics topics are not being included in high school curricula and that this is considered one of the most important issues facing teachers who are teaching statistics to non-specialist students, because these students are studying statistics for the first time at university level. This situation in Saudi Arabia contrasts with several other countries where students study some basic statistical concepts at high school level (Bibby 1986; Holmes 2003; Jacobsen 1989).

Bradstreet (1996); Garfield et al. (2008) and Simpson (1995) have pointed out a common misconception among non-specialist students that statistics is a branch of mathematics, and they argue that this is one of the reasons for their anxiety about statistics. Students often believe that statistics courses will focus on numbers and computations rather than analysing data and interpreting the results. However in this study, whilst students noted difficulties in solving mathematical equations and computational issues as a result of their weakness in mathematics, these students did not indicate the impact of their mathematics level on their ability to analyse data and understand statistical concepts. Similarly, the teachers stated that students' weakness in mathematics led to difficulties in explaining mathematical problems and clarifying equations (theoretical aspects) rather than in analysing data, explaining statistical concepts and interpreting the results (practical aspects).

Against this background, the staff interviews indicated that where they often have large numbers of students in a class this can be an important influence – that can prevent teachers fulfilling students' mathematics needs. Teachers pointed out that the large number of students hindered them in using computer labs, using statistical software programs and doing projects because of their limited capacity to be able to offer one-to-one guidance and due to limitations of time. The large number of students was essentially preventing students from receiving appropriate teaching in statistics. This issue has been raised in several studies that mention the negative effect of a large number of students in a class on students' achievement and the quality of students' engagement (e.g., Glass and Smith 1978; Lucas, Jones, Gibbs, Hughes & Wisker 1996 in Gibbs 2010). Indeed, several studies conducted in the UK found a negative correlation between class size and the average performance of students in most subjects (Gibbs, Lucas & Simonite 1996; Fearnley 1995). However, Gibbs (2010) asserted that *"these negative class-size effect are greatest for younger students and smallest for students 18 or over, but the effects are still quite substantial in higher education,"* (p. 19). Ultimately, such matters do not always fall under the teachers' authority, as most teachers are unable to make any decisions about the number of students in the class. Such decisions are generally made by university and college administrators. Interestingly, concerns about the level of students' mathematics ability as well as the inability to decide the size of classes, are issues shared by colleagues in many other countries including the UK. However, situations differ: for example, anecdotal evidence about current practice at the University of Glasgow contradicts the findings of this study. For instance, the university set up a Maths & Statistics advice service for students several years ago, provided by the Student Learning Service, to try to support all students who are required to study maths and statistics including non-specialist students. This is a good example of one solution that may help support students and that could be adopted in other institutions.

6.3. Students' engagement

The desire and motivation of students to study statistics is one of the most important factors in learning statistics. Based on the students' results in this study, there is no noticeable difference between student engagement in studying statistics at different universities (Factor four). However, the results of the students' questionnaire also showed that 52% of participants did not wish to study another statistics course and 20% did not know whether they did or not (*Table 4-41*). Whilst this might on the surface seem slightly concerning, one of the main reasons for this particular response is that the non-specialist students felt they had studied enough statistics. However, another key reason was that non-specialist students did not see statistics as an interesting subject (*Table 4-42*). In the results of the students' questionnaire, Question 16 illustrates one of the reasons that quite a lot of students did not think their teachers made the classes interactive (*Table 4-3*). And although the majority seemed to be enjoying studying statistics, there are quite a lot of students who were not (Question 31). The relationship between these variables (Questions 16 & 31) was significant: $x^2(16, N = 1034) = 276.76, p < .001$. Furthermore, the relationship between the interactive exercises used by students (Question 17) and their enjoyment (Question 31) was significant: $x^2(16, N = 1020) = 176.2, p < .001$. These results may confirm the important role of the teaching methods used by teachers and their impact on students' learning. This will be discussed further in section 6.5. One possible approach that can enhance the relevance of teaching is following the PCAI framework, and this approach appears to increase students' interest (see section 5.3.1). Furthermore, improving the curriculum by ensuring teaching approaches and materials are more interesting through for example, moving to more interactive and student-centred approaches in teaching statistics is likely to increase students' motivation as several studies have indicated (see section 2.2.1).

In addition, in the teachers' interviews, several teachers mentioned that they followed different ways to make the classroom environment more interactive. One of these methods is to ask students to do group assignments or group projects and present the results to their peers in the classroom and then to discuss the results with each other. Without a doubt, such methods help teachers to follow a more student-centred rather than teacher-centred approach and give students the opportunity to develop deeper and more collaborative approaches to learning (see section 6.5 for more discussion about teachers and their teaching approaches in statistics). However, some teachers in their interviews (Question 13 in section 5.2) pointed out that they struggle to follow student-centred methods where the time that is scheduled for statistics courses is not enough and there are large numbers of students in classes.

The teachers noted that one of the reasons for some students' lack of motivation for statistics is that not all students perceive there to be a link between statistics and their main subjects, nor do they believe that statistics will be needed in their future studies or careers. The differences in students' desire to learn statistics are not surprising, as they are due to the differences in students' attitudes toward statistics. Identifying the attitudes of students toward statistics may help teachers to intervene and adopt teaching approaches to help students to overcome the obstacles they face and enable them to increase their motivation for studying. Gal et al. (1997) suggested that it is helpful to measure students' attitudes before, during and after studying a course of statistics.

Lack of desire to study statistics is not limited to non-specialist students but is also found in specialist students in Saudi Arabia, as staff interviews in the current study indicated. In the eastern region in Saudi Arabia, King Fahad University is the only university offering Bachelors and Masters degrees in statistics. In spite of that, one teacher at this university noted that there were no students registered on either of these degrees programmes in the year the interviews were conducted. Certainly, this reluctance of students to specialise in statistics will adversely affect Saudi Arabia's need for future statisticians. This concern for the future of Saudi statistics can also be seen within the teacher responses, in which only 20% of the teachers who participated were from Saudi Arabia. One teacher pointed out that this is due to lack of awareness of the importance of statistics in various institutions in Arab countries in general. The shortage of specialists is an issue highlighted by research conducted in various countries, such as Kettenring et al. (2004) in the USA, Australian Academy of Science (2006) in Australia, Smith et al. (2007) in the UK. All of these studies have reported a shortage of statisticians in their countries. However, there appear to be no more recent studies confirming this issue, which perhaps suggests that the situation regarding the lack of statisticians in these countries may have changed; certainly no study has ever been conducted in Saudi Arabia to investigate this issue. Researchers in the USA, Australia and the UK have also conducted several studies in the field of statistics education which focus on developing and enhancing existing statistics programmes but such research does not exist in Saudi Arabia and in the Arab countries in general; indeed, Innabi (2014) has pointed out that research in statistics education is overdue in Arab countries.

6.4. The relevance of Statistics courses

The overview in chapter 5 (*Table 5-1*) shows that the contents of statistics courses in different colleges and universities in Saudi Arabia are very similar. This similarity may be due to the limited number of statistics courses, courses may be based on a limited number of key textbooks, or perhaps courses are based upon teachers' experiences of courses elsewhere. However, despite the convergence of statistics courses' content, the results of the students' questionnaire in the current study revealed a variation in students' perception of the relevance of statistics courses to their main subjects in different colleges and universities. For example, the results of question 12 indicated that there is a variation in students' opinions about their statistics courses in different universities (

Table 4-23). Furthermore, a variation in the students' responses emerged from the results of open-ended questions, where the students indicated that the fourth most important issue assisting students in learning statistics is the relevance of statistics courses to their main subject (*Table 4-36*). In keeping with this, the most important factor hindering students' learning of statistics is the irrelevance of statistics courses (*Table 4-37*). This was consistent with the findings that improving the relevance of statistics courses and reducing the contents of statistics courses are the main issues that non-specialist students would like to change in their statistics courses (*Table 4-40*). For participants who did not want to study further statistics courses, the irrelevance of statistics courses was the main reason for their decision (*Table 4-42*).

The results of the current study send an important message to university administrators and the course design committees in those universities. In the interviews, the teachers' mentioned that the design, evaluation and modification of statistics courses are under the authority of those committees rather than individual teachers. It is key that in any attempt to promote curricular changes at this strategic level of universities, that non-specialist students from statistics courses are taken into account, as the results indicated that several statistics courses do not meet the needs of non-specialist students. As mentioned earlier (see section 2.2.3 on Course design), the concept of curricula has changed over the years from just being a list of topics to cover, to instead also include the need to improve students' skills, to enhance the chances to students adopting deep learning approaches and to support students' achievement of range of clear learning objectives and outcomes (Barr et al. 1995; Fink 2007). Course design committees should pay attention to the six elements suggested by Fink (2007) in designing any courses, covering issues such as the importance of applying knowledge learned, as this may help to meet the needs of non-specialist students (see section 2.2.3 on Course design). Furthermore, Cobb (1993) provided several valuable suggestions about introductory statistics courses at university level which should be considered (see section 2.4.1 on Statistics in the curriculum of universities).

However, teachers who teach statistics courses in Saudi universities are also responsible for enhancing the relevance of statistics courses. First, it is important for teachers to identify and clarify the objectives of statistics courses for students and to take into account that these goals should be appropriate to students' main subjects of study Pieraccini (1990) and Schuyten (1990). Second, statistics teachers should be careful in the selection of examples that are appropriate and relevant to the students' main subjects as this can help to demonstrate the importance of statistics to other disciplines as numerous studies, such as Simpson (1995), Everson et al. (2008) and Snee (1993) have pointed out.

6.5. The implications of teachers and their teaching approaches

The results of the students' questionnaires indicated that the impact of teachers and approaches of teaching play a crucial role in to the experiences of non-specialist students learning statistics. One of the five main groups of questions that were obtained from the results of students' questionnaires about the current state of teaching and learning statistics courses in Saudi universities, was the effectiveness of teachers. The results showed slight differences among students' responses concerning their statistics teachers, for instance students' responses to question 17 (*Table 4-21*) . Responses to the open-ended questions of the students' questionnaire indicated that the most important element that helped students in learning statistics was the teachers and the teaching methods they adopt (*Table 4-36*). In the same way, teachers and teaching methods was the second most important element that hindered students learning statistics (*Table 4-37*). The results also indicated that the second most important challenge facing students was the statistics teachers and their teaching methods (*Table 4-39*). In addition, when participants were asked what they would like to change in the statistics courses, teachers and teaching methods was the fourth most important element they indicated (*Table 4-40*). Moreover, for participants who did not want to study further statistics course, teachers and teaching methods was the fifth main reason for their decision (*Table 4-42*). These results indicate the important role of the teacher in influencing student's learning experiences both positively and negatively. The results also suggest that statistics teachers in some colleges may be following unpopular, ineffective or inappropriate teaching approaches within their statistics courses. The importance of teachers and their approaches in teaching is emphasised by several studies such as (Martin et al. 2000; Tishkovskaya et al. 2012; Samuelowicz et al. 2001). This perhaps indicates the need for teachers to receive more support and training in their role as statistics teachers of non-specialist students.

Lack of students' satisfaction with their statistics teachers may be attributed to two reasons. The first reason is that statistics courses were taught by teachers whose specialist subject was not statistics. In the current study, only six of sixteen teachers specialised in statistics and this is likely to affect the students' leaning of statistics. This proposition is supported by several studies showing the existence of misconceptions among some teachers who do not consider statistics to be an independent discipline but a branch of mathematics, and this may lead those teachers to adopt mathematics teaching techniques, which are not entirely appropriate to the teaching of statistics (Cobb et al. 1997; Garfield et al. 2008; Moore 1998). Specialist statistics teachers are likely to teach the subject well but may make weaker links to students' own subjects, but on the other hand, non-statistics teachers are likely to make better connections to the students' subject but are less expert in statistics. The second reason is students lack the opportunity to apply many of the statistical concepts they are learning, so courses often emphasise the theoretical rather than practical. This lack of practical application is illustrated by the results of students' questionnaires which showed that 59% of the participants did not use any statistical software programs during their statistics courses. Unfortunately, the non-use of statistical software programs within courses for non-specialist students contradicts the results of several studies that have pointed to the importance of these programs for all statistics students, as students need to be able to use these programs and to apply what they have learned in future careers (Harraway et al. 2005; Velleman et al. 1996). Participants mentioned that they would like to reduce the volume of the content in statistics courses, but would like to add more examples, projects and application. This coincides with the results of the staff interviews, in which the teachers expressed that due to time constraints, they were unable to apply the second element of the PCAI framework - collecting data - and they suggested that this can prevent students acquiring skills in this area.

The results of teachers' interviews also indicated one more reason for the dissatisfaction of students regarding statistics teachers' approaches to teaching, which is that lecturing is the main method of teaching statistics for the majority of teachers. Only five teachers (three of them from same university) in their interviews mentioned that they have used statistical software programs in teaching statistics courses in order to help students to apply what they have leaned. These findings are compatible with several studies that point to the importance of achieving a balance between theoretical and practical elements in teaching statistics courses to non-specialist students. Application exercises using software programs can help students to improve their skills in the use of statistics in their main subject and to understand the results of their studies (Bradstreet 1996; Snee 1990; Cobb 1993). The rest of the teachers, who are not using statistical software packages, described their approaches to teaching statistics as starting with theoretical parts then moving to the practical. However, many teachers deal with practical by doing exercises and homework that relies on mathematical style reasoning and there is a danger that this may emphasise the misconception among students that statistics is a part of mathematics (Garfield et al. 2008; Simpson 1995; Bradstreet 1996). Undertaking practical exercises is very useful for students, but conducting these exercises without the use of statistical software can leave students with relatively under-developed skills for using these kinds of programs (Snee 1990; Garfield 1988). The lack of practical application mentioned above and an over-reliance on lecture-based teaching may reduce the opportunities for students to actively engage in the educational process and makes them into recipients of information rather than critical contributors to their own learning. This approach is also very teacher-centred. The inadequacy of the learning environment in some institutions, such as the lack of resources for learning statistics in the Arabic language, lack of technological facilities in some institutions, and the weakness in mathematics of some students, are among the factors that may lead teachers to think they cannot follow a student-centred approach.

6.6. The implications of technology in learning and teaching statistics

The use of technology in learning and teaching statistics was a key focus of the current research from early on in the study. The findings indicate that there is a lack of use of technology and its application in teaching statistics to non-specialist students in several colleges. As mentioned in that previous section, 59% of participants did not use any statistical software programmes during their statistics courses. This is inconsistent with several studies that emphasise the importance of technology and its application in the educational process, particularly in learning statistics. For instance, Leece et al. (2011), Cadiero-Kaplan (1999), Ringstaff et al. (2002) and Li (2003) found that the use of technology improved performance, achievement, motivation and interaction of students. Furthermore, Garfield et al. (2002) and Chance et al. (2007) reported that the use of technology provides more opportunities for non-specialist students to apply statistics which improves students' understanding of statistical concepts. The benefits of using technology to teach statistics to non-specialist students is asserted by Basturk (2005), who found that a group of students who were taught introductory statistics with computer assisted instruction improved their understanding of statistical concepts and achieved higher scores in exams. However, the results of the current study indicated differences between students' satisfaction with the use of technology in learning statistics, with participants in some universities expressing greater satisfaction with the use of technology than students in other universities (*Table 4-14* and *Table 4-15*). The results indicated that the difference is due to the availability of technical facilities in the institutions, and the ability of statistics teachers to use statistical software programs in teaching statistics.

It could be argued that the current use of technology in some colleges and universities in Saudi Arabia for teaching statistics may not be commensurate with the status of technology in the twenty-first century. These colleges and universities need to develop their use of technology in teaching statistics to enhance these courses, bearing in mind two key issues.

Firstly, the use of technology in teaching statistics courses may affect the course contents and the way topics are scheduled. Secondly, finding the balance between theoretical and practical elements in statistics courses is an important consideration in supporting non-specialist students to achieve the course objectives. This may involve focusing on the practical application of statistics and understanding statistical concepts rather than performing calculations (Tishkovskaya et al. 2012). As a result, Cauley et al. (2009) and Chance et al. (2007) stress the importance of regularly reviewing statistics courses to ensure they achieve their intended targets.

These points are particularly relevant for some colleges that recorded considerable weaknesses in both the use of technology in statistics and the evaluation of statistics courses. The results of students' questionnaires and staff interviews in one university indicated that no statistical software programs were used and technology was rarely used in teaching statistics. Moreover, one teacher with eleven years of experience in teaching statistics at this university mentioned that in all that time he had not completed a review of any statistics courses.

Providing the opportunity for students to analyse data and acquire data handling skills is an important aspect of technology use in teaching statistics and key for students' future need to be able to apply statistics in work practice (Nicholl, 2001). Furthermore, another advantage of the use of technology that could help students to understand the concepts of statistics topics is the use of computer simulation methods where this approach allows students to clarify the difficult concepts and theories of statistics (Mills, 2002). The issue of the use of technology was emphasised by student respondents who mentioned that they would like to improve their use and application of technology within their statistics courses. Referring back to the College Report (GAISE) which was conducted by Aliaga et al. (2005), one of the recommendations for teaching statistics is the use of technology for analysis and improving students' understanding.

Expanding the use of technology and the application of statistics' in Arab countries, including Saudi Arabia is important in supporting the global influence of the Middle East. One teacher argued that: *"The gap between the developed countries in the West and the Arab world in using and benefiting from Statistics and its applications is so huge. We need a very long time to catch up with them,"* (Teacher 10). The view of this teacher is compatible with the result we have from students' questionnaires, where about 59% of participants have not used any statistical software programs during their statistics courses (*Table 4-4*).

The growth in the use of technology more generally could help in supporting students to learn statistics through the availability of statistics lessons on the internet. Access to this kind of technology and resource could help to fill the existing gap in sources of statistics learning materials in the Arabic language that could contribute to enhancing students' learning as well as improving broader awareness of the importance of statistics and its application to various fields (Everson et al. 2008).

Lack of technology and financial support in some institutions in developing countries compared to Western countries is one of the reasons for the difference between them (Nwezeh 2010). However, this situation does not apply in Saudi Arabia, which might be considered as falling between a developing and developed country and where universities are well funded by the Saudi government. One teacher stated *"I would like to refer to the great role of the university in setting up computer labs and equipping them with the most advanced devices for all students. Also, the university does not hesitate in supplying the latest programs we need,"* (Teacher 7). Therefore, poor use of technology in those institutions where it exists could be considered to be the responsibility of teachers' and their attitudes to using technology, or alternatively senior administrators may have some responsibility if they are providing insufficient technology training for teachers. This corresponds with the diversity of students' responses about their statistics teachers' effective use of technology (Question 26) in different institutions (*Table 4-15*).

The findings indicate that Saudi universities face several obstacles that hinder them in keeping pace with developments in technology in the twenty-first century. The first of these is the lack of tutors to assist teachers in the computer lab. This shortage prevents the division of large numbers of students into smaller group tutorials and limits the use of the computer lab. Secondly, there is a lack of technical staff in these colleges and universities to manage the computer labs and resolve technical problems that teachers face when using technology. Chance et al. (2007) pointed out that the aforementioned difficulties are among the reasons for teachers experiencing an increased burden when they use technology to teach statistics. A third difficulty mentioned by staff in the interviews was statistics teachers' lack of experience of dealing with statistical software programs in Saudi universities. Undoubtedly, this will prevent students from using statistical programs. Where teachers are not specialists in statistics teaching, it could be that this adds to their unfamiliarity with statistics software packages. To address this deficiency, one of the teachers suggested that *"For example, in the UK, where I did my PhD, there were many institutes and qualified instructors who provide a range of training courses, such as training in the use of statistical programs ... Certainly, this offers a great service for those who want to learn how to use these programs,"* (Teacher 14). The fourth reason is statistics teachers' erroneous beliefs about the use of technology. Teachers' interviews highlighted that some statistics teachers believe that statistical software programs are not necessary for non-specialist students. These teachers argued that non-specialist students should undertake their calculations and analyses manually rather than using technology. Teacher 4 commented: *"senior staff members much prefer to make their calculations and analyses manually, arguing that at the time they obtained their PhDs no such advanced programs existed"*. The views of these teachers contrast with the results of the students' questionnaire (question 29), where a high proportion of students from different universities were dissatisfied with the lack of time allocated for learning how to work with statistical software programs. Furthermore, the opinions of those teachers contrast withthe findings of several studies, such as Basturk (2005), Chance et al. (2007) and Garfield et al. (2002) which emphasise that technology is also important for non-specialist students. Finally, and importantly, the lack of general technological facilities at some institutions is the reason for the lack of technology use in teaching statistics.

Technology use is affected by several factors, including English language, as the results of the current study and other studies indicate. The following section will explore the extent of English language influence on the use of technology in Saudi universities; and other possible influences of English in learning and teaching statistics.

6.7. The implications of English language ability in learning and teaching statistics

One of the main factors addressed by the current research is the influence of English language on teaching and learning statistics in Saudi universities. The results of the students' questionnaire, for example, students' responses question 35 revealed that the main language (Arabic or English) which is used in teaching the statistics course affected participants' responses regarding the use of technology (*Figure 4-4*). There is no doubt that one of the important impacts of the English language in learning statistics is that most of the statistical software programs are available only in English. The results of the current study indicated that participants in universities, except one institution, where English is used as the main language, are more satisfied with the use of technology in learning statistics than participants in other universities where English is only the main language in some colleges within the university. In institutions where English is used as the main language, they recorded the lowest level of satisfaction in the use of technology in statistics classes, this is due to the lack of availability of a computer lab with statistical software programs within the institution at the time of conducting this study.

The questionnaire responses indicated that the fifth most important obstacle facing participants in learning statistics is English language and statistics terminology. Statistics teachers also mentioned this difficulty in their interviews. Teacher 16 stated that: *"Most students who fail the course do not understand the meaning of these statistical terms,"* Moreover, the English language affected students' exam results. One teacher said *"I often find in exams that the most common errors in the answer sheet result from students' incorrect understanding of the questions, which affects their final results. The students themselves admit that their level in the English language is not good enough to understand the exam questions,"* (Teacher 7). The views of teachers regarding the effects of English language are compatible with students' responses about the difficulties in accessing statistics resources (question 37) due to students' English ability (*Figure 4-6*).These results are compatible with previous studies conducted by Kaplan et al. (2009); Abdelbasit (2010) and Hubbard (1990), which illustrated the benefits of a good level of English language skills in learning statistics. Furthermore, these studies stressed that where statistics terminology does not have equivalent translation in the local language of non-native English speaking students, this caused difficulties for them in understanding statistics, which in turn, may lead these students to believe statistics is a more complex course than they might otherwise believe.

Participants in institutions where English is the main language of instruction, did not think that any difficulties were caused by students' English language ability. Conversely, participants in other universities where English is used as the main language in only some colleges thought that difficulties were caused by students' English language ability, in areas such as: statistics terminology; the use of statistical software programs in English; and the difficulty obtaining statistics references and resources in their first language.

6.8. Summary

The study aimed to answer the following research questions:

6.8.1. Question 1: How are statistics courses for non-specialist students taught currently in Saudi universities?

The results of this study revealed that most statistics teachers adopt a lecturing approach in teaching statistics courses to non-specialist students in Saudi universities despite evidence of the benefits of student-centred and interactive methods of teaching at university. This corresponds with the existing lack of application of statistical problems in the classroom, which prevents students consolidating what they have learned and developing skills for use in future employment. Furthermore, this study highlighted to the shortcomings in the use of statistical software programs for non-specialist students in Saudi universities. Several factors influenced this shortfall in teaching quality: one being the statistics teachers' lack of experience of dealing with statistical software programs in Saudi universities where most of them were not specialists in statistics. Secondly, the lack of availability of technical facilities, such as computer labs in some institutions. The lack of opportunities for students to apply their statistical knowledge to real and relevant problems appeared to be one of the main reasons for non-specialist students in Saudi universities stating that statistics courses were not important or relevant for them in relation to their main subjects. This also explains the lack of enthusiasm students displayed towards studying further statistics courses in Saudi Arabia. On the other hand, statistics teachers in Saudi universities used assignments, quizzes and exams as the primary assessment methods for non-specialist students. The results revealed that almost all statistics teachers preferred to focus on assessing their students' theoretical capabilities, with the exception of one institution, where students' practical skills using statistical programs were assessed.

Despite the convergence seen in the content of Saudi statistics courses (*Table 5-1*), the results of this study illustrated that several statistics courses did not meet the needs of non-specialist students. However, this situation is different in other institutions where results indicated that some students were satisfied with their statistics courses. Furthermore, the study suggested that the time allocated to statistics courses for non-specialist students in Saudi universities is insufficient. Administrators of universities and colleges in Saudi Arabia played a crucial role in determining the way statistics is taught and the learning environment created for students; they, along with special committees were responsible for designing statistics courses, evaluating these courses and determining the number of students in each class. Moreover, providing enough assistants and technical staff is also in the hands of these administrators.

6.8.2. Question 2: What are the main challenges that face those teaching statistics to non-specialist students in Saudi universities and how have these have been overcome?

AND

Question 3: What are the main challenges that face non-specialist students learning statistics in Saudi universities and how have these have been overcome?

The results of this study showed several challenges that both teachers and non-specialist students face in learning and teaching statistics. The lower levels of mathematical skill among students, particularly those who came from the Humanities stream in high school, is one of these challenges. This issue has caused difficulties for those students in learning statistics; they find it more difficult to do the calculations, while teachers struggle to teach statistics effectively to students with poor maths abilities. Therefore, the first lectures in any statistics course must be used to review the most important topics in mathematics in order to address this weakness; this was a method followed by the more successful statistics teachers in this study.

The irrelevance of statistics courses to the main subjects of non-specialist students in several colleges was often stated as a major difficultly suffered by those students; this led students to believe that statistics was not an important subject for them. As a result, this issue has fostered a distinct lack of enthusiasm among the students towards studying statistics. This lack of enthusiasm caused further difficulties for the statistics teachers dealing with many absent students and groups of unmotivated students.

The results of this study revealed that a teacher-centred approach is the preferred approach followed by most statistics teachers when teaching statistics courses in Saudi universities. However, the results also showed that this approach is not necessarily the most suitable or effective way of teaching statistics courses from both the staff and student perspective.

This study illustrated that the use of technology is one of the most important challenges for teachers and non-specialist students in Saudi universities. The lack of technical facilities in some institutions, lack of experience of statistics teachers in dealing with statistical software programs and the limitation of allocated time were the most frequently stated difficulties in preventing the use of technology in Saudi universities.

Furthermore, this study has shown that the difficulties of learning statistics in English when this is not the students' or teachers' first language causes a range of difficulties when learning and teaching statistics in Saudi universities, particularly in those institutions which do not use English language as the main language. The low levels of English language ability among students in those institutions prevented them from using statistical software programs. Poor English language abilities also prevented some students from accessing further sources of learning statistics that are available in English, for example textbooks and worksheets.

6.8.3. Question 4: How could teaching practice in Saudi Arabia be enhanced to reflect appropriate developments in the rest of the world in teaching statistics to non-specialists?

The current study identified a number of important points that should be taken into account in order to allow Saudi universities to keep pace with the developments in teaching and learning statistics. The first of these is the introduction of some basic concepts of statistics at high school level; here, an improved curriculum could help clarify the importance of statistics in various aspects of modern life. Furthermore, it was established that addressing the existing mathematical weaknesses of the student cohort was of the highest importance. Moreover, when designing the statistics courses, the need for non-specialist students to have the opportunity for more practice using the statistical application should be taken into account, including application using appropriate statistical software programs. Statistics teachers should follow more interactive and student-centred approaches to teaching statistics courses to non-specialist students. In addition, there is an urgent need to increase the availability of additional learning resources for statistics in Arabic, in order to fill the existing gap.

6.9. Recommendations

The current study is, as far as the author is aware, the first study conducted in Saudi Arabia on teaching and learning statistics to non-specialist students at university level. Therefore, the researcher offers several recommendations for addressing inadequacies I have identified and for overcoming obstacles to learning and teaching statistics to non-specialist students in Saudi universities. I recommend that:

1. **Universities should work with high schools to ensure that basic statistics is included in the curriculum in a way that emphasises its importance** in various aspects of life. School students should be encouraged to become statisticians through studying a statistics degree in order to meet the needs of Saudi Arabia for statisticians.
2. **Universities should add an introductory mathematics course** to the study plan for non-specialist students in some academics departments in Saudi universities (particularly for students from the humanity pathway in high school who have not studied mathematics for a long time), and that this course becomes a prerequisite for studying statistics courses.

3. Course design committees should **tailor courses to the needs of non-specialist students** based on their main subjects.
4. Course design committees should **evaluate statistics courses regularly** to identify the strengths and weaknesses of these courses and to continually enhance course provision.
5. University course design committees should consider **giving statistics teachers in Saudi universities power to make some changes to their statistics courses** where they identify suitable improvements resulting from their direct contact with students.
6. **Universities, statisticians and statistics teachers should increase the volume of statistics teaching and learning resources in the Arabic language** that are available for students and staff, through translating books on statistics and providing teaching resources online,.
7. **Universities need to develop training programmes focused on statistical software programs** for statistics teachers who do not have experience in dealing with statistical software programs. Furthermore, training programmes also need to be made available for students who want to improve their ability to use statistical software programs. This would contribute to spreading the use of statistical software programs and their application in Saudi Arabia to help fill the gap that this study identified.
8. **Universities need to develop teaching training programmes** for statistics teachers who do not have experience of teaching in more interactive and student-centred ways. This would contribute to improving the effectiveness of statistics teaching for statistics students, for non-specialist students as well as to enhancing teaching practice across universities. These programmes are mandatory in many universities in the West.
9. Statistics teachers should **increase the opportunities for students to apply statistical concepts** not limit courses to the theoretical aspects of statistics.
10. **The administrators should provide the appropriate educational environment for teaching statistics** such as: increasing the availability of computer labs; investing in, and installing, relevant statistical software programs; and increasing the availability of technical staff to manage the labs.
11. **The administrators of universities and colleges in Saudi Arabia should support students' English language skills development** to ensure they are sufficient for

statistics courses. This might include offering some supplementary English language courses covering relevant statistical terminology to support student learning.

12. **University course design committees allocate extra time to statistics courses for non-specialist students,** as most statistics teachers who participated in the current study mentioned this as being key to successful outcomes for students.
13. **Higher Educational institutions should be encouraged to provide postgraduate programmes focused on Statistics Education** and should work to motivate researchers to conduct studies within this field in order to help fill the gap in this type of research in Saudi Arabia and improve the statistics teaching methods for both statisticians and non-statisticians.

6.10. Limitations of the study

This study had several limitations. A mixed methods approach was used to achieve the goals of the study. The researcher used interviews with teachers of statistics. Additional qualitative tools could have been used, such as observations, in order to enhance the credibility of the data from interviews and to triangulate the data gathered through different methods. Furthermore, for cultural reasons, this study was limited to mostly male non-specialist students, because this was the only population that the researcher could have access to within the cultural norms of Saudi universities. However, with some help from female staff in some institutions, a smaller number of female students participated in this study, although there were far fewer of them than there were male students. In addition, this study was limited in terms of the cross-referencing of responses between students and teachers. It was impossible to do this directly, since there was no one-to-one correspondence between the teachers who were interviewed and the courses taken by the students who filled out the questionnaires. However, the analysis that has highlighted institutional differences has gone some way to addressing the connections between student and staff responses.

Another limitation is that the current study was limited to statistics teachers and non-specialist students. Course design, evaluation committee members and the leaders of colleges and universities play a crucial role in statistics courses and teaching for non-specialist students in Saudi Arabian universities; thus the researcher recognises the limitations of not having collected data from these groups.

In addition, it could be argued that the methods of analysis chosen depended on some assumptions and approaches that are not wholly valid. In particular, Factor Analysis has been carried out on Likert scale variables. In spite of the amount of analysis required, it might be better to carry out the multi-level modelling question by question using appropriate methods for ordinal scale data. However, this would require a lot more subjects to be recruited for models to be fitted at three or four levels, to avoid the problem of having many empty cells. Moreover, it is acknowledged that only a straightforward modelling approach has been applied regarding the multi-level structure (student within department within college within university). Other possibilities exist, for instance grouping students by their discipline as well as their university and/or college. Although the exploratory data analysis suggested very strongly that the students' university is a much more influential factor than their discipline, further work might usefully be done to explore models where discipline is used to help define clusters of students.

6.11. Suggestion for future research

As far as the author is aware, the current study is the only study on learning and teaching statistics to non-specialist students conducted in Saudi Arabia to date. Therefore, this study has been relatively broad because it includes several large scale aspects that must be investigated in order to identify the current situation of learning and teaching statistics. I have considered the present study as a first step in developing this type of research in Saudi Arabia. There remain many areas of research which could be conducted in Saudi Arabia, such as studies on assessment methods, teaching methods, the use of technology and students' attitudes toward statistics; such research would offer more guidance and benefits to teachers of statistics in Saudi Arabia as well as establishing better qualified statistics graduates for the Saudi Arabian employment market.

6.12. Conclusion

In reflecting back on this study, the researcher successfully carried out a substantial piece of educational research in Saudi Arabia, where there has been little done before. Data collection instruments were developed and used to obtain responses from 1053 non-specialist students and 16 teachers of statistics from six universities in Saudi Arabia's Eastern Region. Although the present study illustrates the need for further research within the statistics education field in Arab countries, particularly in Saudi Arabia, to keep up with the research and teaching developments in Western countries, it also demonstrates the possibility of achieving the required fieldwork for this kind of research.

Several of the issues about learning and teaching statistics to non-specialist students that are highlighted in this study, such as mathematics ability level, lack of technical staff, large classes and teachers not using interactive teaching approaches, are common in Western countries too. However, in Saudi Arabia more difficulties in learning and teaching statistics are experienced, notably that students whose English language ability is not as good face particular problems using statistical software programs which have English command structures, and who suffer from a lack of Arabic statistics resources such as books and journals, compared to those available in English.

The literature review revealed the importance of statistical software programs to non-specialist students. One important point is that statistics teachers who are not experienced in using those programs need to be enthusiastic about improving themselves in order to be able to help their students to use them. In addition, a lack of availability of statistical programs in some institutions in Saudi Arabia should not prevent statistics teachers from finding alternatives; there are some programs that are widely available (such as Excel which is also available in an Arabic version except for the functions symbols, which are again in English) that provide acceptable platforms for the application of basic statistical concepts. Such a program might be easier to use for those students whose language ability is not good but it would still undoubtedly help to develop students' skills in data analysis.

The current study has highlighted that some statistics teachers are not using the most effective teaching approaches in teaching statistics to non-specialists and that seems to influence the students' views of their statistics courses. Therefore, further research might need to focus on learning from the extensive research from the UK, USA and Australia focused on teaching excellence and the development of university teachers. This area would help to develop effective and evidence-based statistics teaching approaches in Saudi Arabia through offering new suggestions and solutions to overcome the obstacles that face statistics teachers and students.

Finally, this study sought to investigate the current state of teaching and learning statistics for non-specialist students in Saudi universities and the factors that affect the teaching of statistics courses. The findings of the current study showed the existence of shortcomings in teaching and learning statistics to those students in Saudi universities that require more attention in order to meet the needs of non-specialist students from statistics courses. Hopefully, this study will prove to be the first step towards meeting the shortage of Statistics Education researchers in Saudi Arabia, and towards these future researchers seeking to develop this important area of research.

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Appendix A. Information letter for students

University of Glasgow | School of Mathematics & Statistics

Information letter for participants

Researcher name: Abdullah Mohammed Alomir

Research title: **"The experience of teaching statistics to non-specialist students in Saudi universities"**

Dear Student,

I am a lecturer at Al-imam Mohammed ibn Saud University – Al-Hassa branch, and also currently a PhD student at the School of Mathematics and Statistics – University of Glasgow. For my research project, I am trying to find out the current state of methods of learning and teaching statistics in Saudi universities, especially statistics courses which are taught to non-specialist statistical students. Because you are a non-specialist student in this university, I am inviting you to participate in my research study by completing this questionnaire.

The following questionnaire will require approximately 15 minutes to complete. There are no risks associated with participating in this study. In order to ensure that all information will remain confidential, please do not include your name. If you choose to participate in this project, please answer all questions as honestly as possible. Your participation in this study is voluntary.

Thank you for taking the time to assist me in my PhD research project. The data collected will provide useful information to indicate what the strengths and weaknesses are of teaching statistics courses to non-specialist students, what the challenges are to improving statistics courses in Saudi universities, and will also provide a comparison of statistics teaching in Saudi Arabia with the UK.

If you have any questions regarding the survey or this research project in general, also if you have any questions concerning your rights as a research participant please contact the researcher or the research supervisors.

By completing and submitting this survey, you are indicating your consent to participate in the study. Your participation is appreciated.

Researcher:

Abdullah Mohammed Alomir Email: 1103180a@student.gla.ac.uk

Research supervisors:

Prof. John McColl Email: john.mccoll@glasgow.ac.uk

Dr. Catherine Bovill Email: catherine.bovill@glasgow.ac.uk

Appendix B.   Students questionnaire

Personal details

1. University: .... College/ Faculty: ....
2. Main subject of study: ....
3. Sex: ☐ Male   ☐ Female
4. What path did you follow in high school?

   ☐ Scientific   ☐ Humanity   ☐ Management
5. What level of study are you at now?

   ☐ Undergraduate → in which semester are you now? (foundation year not included)

   ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8

   ☐ Postgraduate
6. How many statistics courses have you completed at university?

   ☐ One course   ☐ two courses   ☐ three or more
7. At what stage in your degree have you studied statistics? (tick as many boxes as are applicable)

   ☐ Undergraduate → in which semester? (foundation year not included)

   ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8

   ☐ Postgraduate

Background

8. How many hours weekly have you spent outside of lectures studying your statistics course on your own or with friends?

   ☐ Less than an hour   ☐ One to Two hours   ☐ Three hours or more
9. What language was mainly used by teacher in your most recent statistics course taught in?

   ☐ Arabic   ☐ English
10. What is the level of your English Language skills?
    - Reading: ☐ Excellent   ☐ Good   ☐ Poor
    - Writing: ☐ Excellent   ☐ Good   ☐ Poor

- Speaking: ☐ Excellent ☐ Good ☐ Poor
- Listening: ☐ Excellent ☐ Good ☐ Poor

Most recent statistics course:

Thinking about the most recent statistics course you have studied, to what extent do you agree with the following statements: (strongly disagree 1 – disagree 2 – neutral 3 – agree 4 – strongly agree 5), if the statement is not applicable to your recent statistics course you have taken please choose (not applicable 6)

		Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**		**N/A**
		1	**2**	**3**	**4**	**5**		**6**
During my most recent statistics course;								
11	The teacher was knowledgeable about statistics.	☐	☐	☐	☐	☐		☐
12	The contents of the course were relevant to my main subject of study.	☐	☐	☐	☐	☐		☐
13	The examples which were used in the course were relevant to my main subject.	☐	☐	☐	☐	☐		☐
14	The importance of the course to my main subject was clarified at the beginning of the statistics course.	☐	☐	☐	☐	☐		☐
15	The criteria which were used to grade my course assessments were clarified at the beginning of the course.	☐	☐	☐	☐	☐		☐
16	The teaching methods used by the teacher helped me to learn effectively.	☐	☐	☐	☐	☐		☐
17	The teacher engaged the students using interactive exercises.	☐	☐	☐	☐	☐		☐
18	The teacher was receptive to students' questions.	☐	☐	☐	☐	☐		☐
19	I found it difficult to find good statistics resources and references that were relevant to my main subject.	☐	☐	☐	☐	☐		☐
20	I was able to complete the work of the course in the time available.	☐	☐	☐	☐	☐		☐

21. Is statistics the main specialist subject of your teacher?

☐ No ☐ Yes ☐ Do not know

22. Have you used any statistical software programs during your statistical courses?

☐ No ☐ Yes

- **If (Yes)** → 22a. What programs have you used? (you can choose more than one):

☐ Excel ☐ SPSS ☐ SAS ☐ JMP ☐ R ☐ Minitab

☐ Other (please specify): ....

23. What kinds of activities did you do as part of your statistics course? (tick all those that apply)

		With the lecturer	With a group of other students	On my own
a	Solve statistical problems	☐	☐	☐
b	Undertake projects involving the use of statistical concepts	☐	☐	☐
c	Discussion and conversation	☐	☐	☐
d	Data analysis using a computer	☐	☐	☐
e	Homework	☐	☐	☐

24. What are the two most important things that helped your learning of statistics on this course?

1.

2.

25. What are the two most important things that did not help your learning of statistics on this course?

1.

2.

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree		N/A
		1	2	3	4	5		6
Using technology in my Statistics course;								
26	The teacher used technology (e.g. PowerPoint, the internet, statistical packages) effectively to help teach this course.	☐	☐	☐	☐	☐		☐
27	Using a statistical software program led me to concentrate on the technology and not the statistical concepts being taught.	☐	☐	☐	☐	☐		☐
28	Using a statistical software program to compute the statistical problems caused me misunderstanding of some steps of statistical procedures.	☐	☐	☐	☐	☐		☐
29	Enough time was spent in learning and using a statistical software program.	☐	☐	☐	☐	☐		☐
30	I could have used technology to learn statistics just as effectively without the teacher.	☐	☐	☐	☐	☐		☐
After completing the Statistics course;								
31	I am enjoying studying statistics.	☐	☐	☐	☐	☐		☐
32	I will be able to apply the statistical concepts I learned from the course in my main subject.	☐	☐	☐	☐	☐		☐
33	I will be able to apply the statistical concepts I learned from the course in my future employment.	☐	☐	☐	☐	☐		☐
Based on English Language skills;								
34	Some statistical technical words which are not translated into my language make it difficult for me to learn statistics.	☐	☐	☐	☐	☐		☐
35	Most statistical software programs are in English and this make it difficult to learn statistics.	☐	☐	☐	☐	☐		☐
36	My lack of English language skills is an obstacle to me using statistical software programs.	☐	☐	☐	☐	☐		☐

37	My level of English language skills has prevented me from accessing statistics resources and references in the English language.	☐	☐	☐	☐	☐		☐

More general views of statistics courses

38. Have you ever studied a statistics course at another university?

☐ No ☐ Yes

- **If (Yes)** → 38a. At what University? .... Country: ....

38b. How did this course/these courses compare to the most recent statistics course you studied in this university?

....

....

39. Have you faced any challenges in studying statistics?

☐No ☐Yes

- **If (Yes)** → 39a. What are the most important challenges you have faced? (maximum two)

1.
2.

→ 39b. How have your teachers helped you to overcome these challenges?

....

....

40. What would you like to change about statistics courses for non-specialist students in your university? (maximum two suggestions)

1.
2.

41. Would you like to study another statistics course? What are the reasons?

☐ No ☐ Yes ☐ Do not know

- The reasons: (maximum two)

  1.

  2.

Appendix C. Information letter for students (Arabic)

University of Glasgow | School of Mathematics & Statistics

ورقة معلومات للمشاركين

اسم الباحث: **عبدالله بن محمد العمير**

عنوان البحث: **"خبرة تدريس الإحصاء للطلاب غير المتخصصين في الجامعات السعودية"**

عزيزي الطالب/الطالبة

أفيدكم علماً بأني محاضر بجامعة الإمام محمد بن سعود الإسلامية – فرع الأحساء، وباحث دكتوراه بجامعة جلاسكو بالمملكة المتحدة. أسعى في مشروعي البحثي معرفة الوضع الحالي لطرق تعلم وتدريس الإحصاء المستخدمة حالياً في الجامعات السعودية خاصة مقررات الإحصاء التي تُدرس للطلاب غير المتخصصين. ولأنك طالب غير متخصص في الإحصاء في هذه الجامعة فإني أدعوك للمشاركة في دراستي البحثية من خلال إكمال هذه الاستبانة.

إكمال الاستبانة سوف يتطلب من الوقت 15 دقيقة تقريباً. لا توجد أي مخاطر مرتبطة بمشاركتك في هذه الدراسة. لضمان أن جميع المعلومات ستبقى سرية الرجاء عدم كتابة اسمك. في حال اختيارك المشاركة في هذه الدراسة، الرجاء الإجابة عن جميع الأسئلة بصدق وصراحة قدر المستطاع. مشاركتك في هذه الدراسة تطوعية.

شكراً لك على وقتك ومساعدتك لي في مشروعي البحثي لمرحلة الدكتوراه. ستقدم البيانات التي سيتم جمعها معلومات مفيدة تشير إلى مواطن القوة والضعف في تدريس مقررات الإحصاء للطلاب غير المتخصصين ، وماهي التحديات لتطوير مقررات الإحصاء في الجامعات السعودية؟ ستقدم هذه الدراسة أيضاً مقارنة لتدريس الإحصاء في المملكة العربية السعودية والمملكة المتحدة.

إذا كان لديك أي سؤال تجاه الاستبانة أو تجاه هذا المشروع البحثي بصفة عامة، أيضاً إذا كان لديك استفسار يتعلق بحقوقك كمشارك في البحث الرجاء التواصل مع الباحث أو المشرفين الدراسيين.

من خلال إكمالك للاستبانة وتقديمها فأنت تشير إلى موافقتك على المشاركة في هذه الدراسة. مشاركتك محل التقدير.

شكراً لمشاركتك في هذه الدراسة

الباحث: **عبدالله بن محمد العمير** البريد الإلكتروني: 1103180a@student.gla.ac.uk

المشرفان الدراسيان: **Prof. John McColl** البريد الإلكتروني: john.mccoll@glasgow.ac.uk

Dr. Catherine Bovill البريد الإلكتروني: catherine.bovill@glasgow.ac.uk

Appendix D. Students questionnaire (Arabic)

البيانات الشخصية:

1. الجامعة: .... الكلية: ....
2. التخصص الدراسي: ....
3. الجنس: ☐ ذكر ☐ أنثى
4. ما هو مجال دراستك في المرحلة الثانوية؟

☐ علمي ☐ أدبي ☐ إداري

5. ما هي مرحلتك الدراسية الحالية؟

☐ بكالوريوس: بأي مستوى دراسي أنت حاليا؟ (المستويات لا تتضمن السنة التحضيرية)

1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐

☐ دراسات عليا

6. كم عدد مقررات الإحصاء التي أكملت دراستها في الجامعة؟

☐ مقرر واحد ☐ مقرران ☐ ثلاث مقررات أو أكثر

7. ماهي المستويات الدراسية التي درست فيها مقرر الإحصاء؟ (يمكنك اختيار عدة مستويات)

☐ بكالوريوس: بأي مستوى دراسي؟ (المستويات لا تتضمن السنة التحضيرية)

1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐

☐ دراسات عليا

معلومات عامة:

8. كم عدد الساعات الأسبوعية التي قضيتها خارج المحاضرات لدراسة مقرر الإحصاء لوحدك أو مع زملائك؟

☐ أقل من ساعة ☐ من ساعة إلى ساعتين ☐ ثلاث ساعات أو أكثر

9. ماهي اللغة المستخدمة بشكل رئيسي من قبل الأستاذ في تدريس آخر مقرر للإحصاء؟

☐ العربية ☐ الإنجليزية

10. ما هو مستوى مهاراتك في اللغة الإنجليزية؟

- القراءة: ☐ ممتاز ☐ جيد ☐ ضعيف
- الكتابة: ☐ ممتاز ☐ جيد ☐ ضعيف
- التحدث: ☐ ممتاز ☐ جيد ☐ ضعيف

- الاستماع: ☐ ممتاز ☐ جيد ☐ ضعيف

آخر مقرر للإحصاء:

من خلال دراستك لآخر مقرر للإحصاء، إلى أي مدى أنت موافق مع العبارات التالية: (غير موافق بشدة 1 – غير موافق 2 – محايد 3 – موافق 4 – موافق بشدة 5)، وإذا كانت العبارة لا تنطبق مع آخر مقرر للإحصاء قد قمت بدراسته الرجاء اختيار (لا ينطبق 6).

		غير موافق بشدة	غير موافق	محايد	موافق	موافق بشدة		لا ينطبق
		1	2	3	4	5		6
خلال دراستي لآخر مقرر للإحصاء								
11	الأستاذ كان على دراية بالإحصاء.	☐	☐	☐	☐	☐		☐
12	محتويات المقرر كانت ذات صلة بتخصصي الدراسي.	☐	☐	☐	☐	☐		☐
13	الأمثلة المستخدمة في المقرر كانت ذات صلة بتخصصي الدراسي.	☐	☐	☐	☐	☐		☐
14	أهمية مقرر الإحصاء تجاه تخصصي الدراسي كان موضحاً في بداية المقرر.	☐	☐	☐	☐	☐		☐
15	المعايير المستخدمة في التقييم وتوزيع الدرجات كانت موضحة في بداية المقرر.	☐	☐	☐	☐	☐		☐
16	طرق التدريس المستخدمة من قبل الأستاذ ساعدتني على التعلم بفاعلية.	☐	☐	☐	☐	☐		☐
17	الأستاذ شجع الطلاب على استخدام الأنشطة التفاعلية.	☐	☐	☐	☐	☐		☐
18	المعلم كان متقبلاً لأسئلة الطلاب.	☐	☐	☐	☐	☐		☐
19	وجدت أنه من الصعوبة الحصول على مصادر ومراجع للإحصاء ذات صلة بتخصصي الدراسي.	☐	☐	☐	☐	☐		☐
20	كنت قادر على إكمال الأعمال المتعلقة بالمقرر في الوقت المتاح.	☐	☐	☐	☐	☐		☐

21. هل الإحصاء هو التخصص الرئيسي لأستاذك الذي درَسك مقرر الإحصاء؟

☐ لا ☐ نعم ☐ لا أعلم

22. هل استخدمت أياً من البرامج الإحصائية خلال دراستك لمقرر الإحصاء؟

☐ لا ☐ نعم

- **إذا كانت الإجابة (نعم)** – 22 أ. ما هي البرامج التي استخدمتها؟ (يمكنك اختيار أكثر من واحد)

☐ Excel ☐ SPSS ☐ SAS ☐ JMP ☐ R ☐ Minitab

☐ أخرى (الرجاء تحديدها) ....

23. ماهي أنواع الأنشطة التعليمية التي قمت بها كجزء من مقرر الإحصاء؟ (يمكنك اختيار عدة خيارات للنشاط الواحد)

		مع الأستاذ	مع مجموعة من الطلاب الآخرين	وحدي
أ	حل المسائل الإحصائية	☐	☐	☐
ب	القيام بمشاريع تتضمن استخدام المفاهيم الإحصائية	☐	☐	☐
ج	المناقشة والحوار	☐	☐	☐
د	تحليل البيانات باستخدام الكمبيوتر	☐	☐	☐
هـ	واجب منزلي	☐	☐	☐

24. ما أهم شيئين ساعداك على تعلم الإحصاء في هذا المقرر؟

1.
2.

25. ما أهم شيئين لم يساعداك على تعلم الإحصاء في هذا المقرر؟

1.
2.

		غير موافق بشدة	غير موافق	محايد	موافق	موافق بشدة		لا ينطبق
		1	2	3	4	5		6
استخدام التكنولوجيا في مقرر الإحصاء								
26	الأستاذ استخدم التكنولوجيا (كالبوربوينت، الإنترنت، البرامج الإحصائية) بفاعلية للمساعدة في تدريس المقرر.	☐	☐	☐	☐	☐		☐
27	استخدام البرامج الإحصائية قادني إلى التركيز على التكنولوجيا وليس على المفاهيم الإحصائية التي تُدرس.	☐	☐	☐	☐	☐		☐
28	استخدام البرامج الإحصائية لحساب المسائل الإحصائية سبب لي سوء فهم لبعض خطوات حل هذه المسائل.	☐	☐	☐	☐	☐		☐
29	الوقت الذي قضيته لتعلم واستخدام البرامج الإحصائية كان كافياً.	☐	☐	☐	☐	☐		☐
30	بإمكاني استخدام التكنولوجيا لتعلم الإحصاء بفاعلية من غير الأستاذ.	☐	☐	☐	☐	☐		☐
بعد إكمالي لمقرر الإحصاء								
31	أنا استمتع بدراسة الإحصاء.	☐	☐	☐	☐	☐		☐
32	سأكون قادراً على تطبيق المفاهيم الإحصائية التي تعلمتها من المقرر في تخصصي الدراسي.	☐	☐	☐	☐	☐		☐
33	سأكون قادراً على تطبيق المفاهيم الإحصائية التي تعلمتها من المقرر في مجال وظيفتي مستقبلاً.	☐	☐	☐	☐	☐		☐
بناء على مهارات اللغة الإنجليزية								
34	بعض المصطلحات الإحصائية التي لم تترجم إلى لغتي جعلت من الصعب علي تعلم الإحصاء.	☐	☐	☐	☐	☐		☐
35	أغلب البرامج الإحصائية باللغة الإنجليزية وهذا يسبب لي صعوبات في تعلم الإحصاء.	☐	☐	☐	☐	☐		☐
36	نقص مهاراتي في اللغة الإنجليزية يعتبر عائقاً لي عند استخدام البرامج الإحصائية.	☐	☐	☐	☐	☐		☐

37	مستواي في مهارات اللغة الإنجليزية منعني من الوصول إلى مراجع ومصادر الإحصاء باللغة الإنجليزية.	☐	☐	☐	☐	☐		☐

الرؤية تجاه مقررات الإحصاء بصفة عامة:

38. هل سبق أن درست مقرراً للإحصاء في جامعة أخرى؟

☐ لا ☐ نعم

- **إذا كانت الإجابة (نعم)** – 38 أ. بأي جامعة؟ .... الدولة: ....

38ب. كيف كان هذا المقرر/ هذه المقررات مقارنة بآخر مقرر للإحصاء درسته في هذه الجامعة؟

....

....

39. هل واجهت أي تحديات عند دراستك للإحصاء؟

☐ لا ☐ نعم

- **إذا كانت الإجابة (نعم)** -- 39 أ. ما هي أهم هذه التحديات التي واجهتك؟ (اثنان كحد أعلى)

1.

2.

39 ب. كيف كانت مساعدة أستاذك لك لتخطي هذه التحديات؟

....

....

40. ما الذي ترغب تغييره في مقررات الإحصاء لغير المتخصصين في جامعتك؟ (اثنان كحد أعلى)

1.

2.

41. هل ترغب بدراسة مقرر للإحصاء مرة أخرى؟ وما هي الأسباب؟

☐ لا ☐ نعم ☐ لا أعلم

- الأسباب: (اثنان كحد أعلى)

1.

2.

Appendix E. Information letter for teachers

University of Glasgow | School of Mathematics & Statistics

Information letter for participants

Researcher name: **Abdullah Mohammed Alomir**

Research title: **"The experience of teaching statistics to non-specialist students in Saudi universities"**

Dear Teacher,

I am a lecturer at Al-imam Mohammed ibn Saud University – Al-Hassa branch, and also currently a PhD student at the School of Mathematics and Statistics – University of Glasgow. For my research project, I am trying to find out the current state of methods of learning and teaching statistics in Saudi universities, especially statistics courses which are taught to non-specialist statistical students. Because you are a statistics teacher in this university, I am inviting you to participate in my research study by completing this interview.

The following interview will take approximately 40 minutes. There are no known or anticipated risks associated with participating in this study. With your permission, the interview will be recorded to facilitate collection of information, translation to English language and later transcription for analysis. All information you provide is considered completely confidential. Your name or any other personal identifying information will be known only for the researcher and his supervisors, and will not appear in the project research paper resulting from this study; however, with your permission anonymous quotations may be used. Notes and tapes collected during this study will be retained for six months after I have completed my PhD thesis in a secure location and then destroyed.

If you choose to participate in this project, please sign the **consent form**. Your participation in this study is voluntary. You may decline to answer any of the interview questions if you so wish. Further, you are free to withdraw your participation from this study at any time.

Thank you for taking the time to assist me in my PhD research project. The data collected will provide useful information to indicate what the strengths and weaknesses are of teaching statistics courses to non-specialist students, what the challenges are to improving statistics courses in Saudi universities, and will also provide a comparison of statistics teaching in Saudi Arabia with the UK.

If you have any questions regarding the survey or this research project in general, also if you have any questions concerning your rights as a research participant please contact the researcher or the research supervisors.

By signing and submitting the **consent form**, you are indicating your consent to participate in the study. Your participation is appreciated.

Thank you for your participation in my study

Researcher:

Abdullah Mohammed Alomir Email: 1103180a@student.gla.ac.uk

Research supervisors:

Prof. John McColl Email: john.mccoll@glasgow.ac.uk

Dr. Catherine Bovill Email: catherine.bovill@glasgow.ac.uk

Appendix F. Consent form for teachers

University of Glasgow | School of Mathematics & Statistics

CONSENT FORM

I have read the information presented in the information letter about a study being conducted by **Abdullah Mohammed Alomir** for **"The experience of teaching statistics to non-specialist students in Saudi universities"** PhD research project at the School of Mathematics and Statistics – University of Glasgow. The research supervisors are **Prof. John McColl** and **Dr. Catherine Bovill.** I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that excerpts from the interview may be included in the research project paper, with the understanding that the quotations will be anonymous.

I have been informed that my participation in this study is voluntary and I may withdraw my consent at any time by advising the researcher.

I am aware that participation in this research study has no effect on my current employment.

* I agree to participate in this study. ☐ Yes ☐ No

*I agree to have my interview tape recorded. ☐ Yes ☐ No

*I agree to the use of anonymous quotations in the PhD thesis and any associated publications.
☐ Yes ☐ No

Participant Name: ....

Signature: ....

University: ....

Email: ....

Date: ....

Thank you for your participation in my study

Appendix G. Teachers interviews questions

Staff Interview Questions

Background:

1. What is your main subject?
2. What is the highest qualification you have in Statistics? From where (university & country)?
3. For how long have you taught statistics to non-specialist students in this university?

Interview:

4. What are the main teaching methods you use in your Statistics courses for non-specialist students?
5. What assessment methods do you use in your Statistics courses for non-specialist students?
6. What are your main aims in teaching Statistics to non-specialist students?
7. How do these aims affect your teaching?
8. In your opinion, what have been the most important developments in Statistics in the past twenty years?
    - How have the Statistics courses in your university changed to reflect these developments?
    - When would the course next be reviewed?
9. This diagram (show separate card/sheet) shows the PCAI framework for statistical investigations.
    - Do you introduce this framework to non-specialist students?

    → **If YES**, how useful do you find the PCAI approach?

    → **If NO**, how useful do you think it would be to incorporate this framework into your teaching?
10. The teaching of statistics has been greatly influence by the use technology e.g. using PowerPoint in presentations, referring students to YouTube and other web resourses and using statistical software programs in the teaching of the statistics.
    - Do you use technology in teaching Statistics to non-specialist students? **if yes,** can you tell me a bit about how you use technology in your teaching?
    - In your experiences, what are the main challenges to using technology in Statistics courses?

11. How can the limited English language skills of some Saudi students affect their learning of Statistics?
12. What are the most important challenges you have faced in teaching Statistics to non-specialist students? How have you overcome these challenges?
13. If you could make some suggestions about teaching Statistics to non-specialist students at your own university, what changes would you suggest making?
14. Do you have any experience of teaching statistics courses offered anywhere else in the world?
    - **If (Yes) →** where? How long? How did it differ from your experiences of teaching statistics in this university?

Appendix H. Information letter for teachers (Arabic)

University of Glasgow | School of Mathematics & Statistics

ورقة معلومات للمشاركين

اسم الباحث: **عبدالله بن محمد العمير**

عنوان البحث: **"خبرة تدريس الإحصاء للطلاب غير المتخصصين في الجامعات السعودية"**

عزيزي أستاذ المقرر

أفيدكم علماً بأني محاضر بجامعة الإمام محمد بن سعود الإسلامية – فرع الأحساء، وباحث دكتوراه بقسم الرياضيات والإحصاء - جامعة جلاسكو بالمملكة المتحدة. أسعى في مشروعي البحثي معرفة الوضع الحالي لطرق تعلم وتدريس الإحصاء المستخدمة حالياً في الجامعات السعودية خاصة مقررات الإحصاء التي تُدرس للطلاب غير المتخصصين. ولكونك أستاذ لمقررات الإحصاء في هذه الجامعة فإني أدعوك للمشاركة في دراستي البحثية من خلال المشاركة في هذه المقابلة.

المقابلة التالية سوف تتطلب 40 دقيقة. لا توجد أي مخاطر معروفة أو متوقعة مرتبطة بمشاركتك في هذه الدراسة. بعد موافقتك، هذه المقابلة سوف تكون مسجلة لتسهيل جمع المعلومات ولترجمتها إلى اللغة الإنجليزية وكتابتها لاحقاً للتحليل. جميع المعلومات التي ستذكرها ستعامل بسرية تامة. اسمك وبياناتك الشخصية الأخرى ستكون معلومة للباحث والمشرفين الدراسيين فقط، ولن تكون ظاهرة في صفحات نتائج هذا المشروع البحثي ولكن بعد موافقتك قد تستخدم بعض الاقتباسات في البحث وستكون مجهولة. سوف تحفظ الملاحظات والتسجيلات التي تم جمعها في هذه الدراسة لمدة ستة أشهر بعد الانتهاء من رسالة الدكتوراه في مكان آمن بعدها ستُتلف.

الرجاء توقيع نموذج الموافقة إذا اخترت المشاركة في هذه الدراسة. مشاركتك في هذه الدراسة تطوعية. باستطاعتك رفض الإجابة عن أي سؤال من أسئلة المقابلة إذا كنت ترغب ذلك ولك الحرية في الانسحاب من المشاركة في هذه الدراسة بأي وقت.

شكراً لك على وقتك ومساعدتك لي في مشروعي البحثي لمرحلة الدكتوراه. ستقدم البيانات التي سيتم جمعها معلومات مفيدة تشير إلى مواطن القوة والضعف في تدريس مقررات الإحصاء للطلاب غير المتخصصين، وماهي التحديات لتطوير مقررات الإحصاء في الجامعات السعودية. ستقدم هذه الدراسة أيضاً مقارنة لتدريس الإحصاء في المملكة العربية السعودية والمملكة المتحدة.

إذا كان لديك أي سؤال تجاه الاستبانة أو تجاه هذا المشروع البحثي بصفة عامة، أو إذا كان لديك استفسار يتعلق بحقوقك كمشارك في البحث الرجاء التواصل مع الباحث أو المشرفين الدراسيين.

من خلال توقيعك لنموذج الموافقة فأنت تشير إلى موافقتك على المشاركة في هذه الدراسة. مشاركتك محل التقدير.

شكراً لمشاركتك في هذه الدراسة

الباحث: **عبدالله بن محمد العمير** البريد الإلكتروني: 1103180a@student.gla.ac.uk

المشرفان الدراسيان: **Prof. John McColl** البريد الإلكتروني: john.mccoll@glasgow.ac.uk

Dr. Catherine Bovill البريد الإلكتروني: catherine.bovill@glasgow.ac.uk

Appendix I. Consent form for teachers (Arabic)

University of Glasgow | School of Mathematics & Statistics

نموذج الموافقة

لقد قرأت المعلومات الموضحة في صفحة المعلومات والمتعلقة بهذه الدراسة لصاحبها **"عبدالله بن محمد العمير"** والتي بعنوان **"خبرة تدريس الإحصاء للطلاب غير المتخصصين في الجامعات السعودية"** كمشروع بحثي لمرحلة الدكتوراه بقسم الرياضيات والإحصاء – جامعة جلاسكو (المملكة المتحدة). المشرفان الدراسيان هما: **Prof. John McColl** و **Dr. Catherine Bovill**.

أعطيت الفرصة لتوجيه أي سؤال ذي علاقة بهذه الدراسة للحصول على إجابة مرضية لسؤالي ولأي معلومات إضافية أريدها.

أنا على علم بأن مقتطفات من هذه المقابلة ستكون متضمنة في المشاريع البحثية مع الفهم بأن هذه الاقتباسات ستكون مجهولة.

أنا على علم بأن مشاركتي في هذه الدراسة تطوعية وبإمكاني سحب موافقتي بأي وقت عن طريق إخبار الباحث.

أنا على علم بأن المشاركة في هذه الدراسة ليس لها أي تأثير على وظيفتي الحالية.

- أوافق على المشاركة في هذه الدراسة ☐ نعم ☐ لا
- أوافق على تسجيل مشاركتي صوتياً ☐ نعم ☐ لا
- أوافق على أي اقتباسات مجهولة في رسالة الدكتوراه للباحث وأي مشاركة بحثية أخرى ☐ نعم ☐ لا

اسم المشارك: ....

التوقيع: ....

الجامعة: ....

الإيميل: ....

التاريخ: ....

Appendix J. Teachers interviews questions (Arabic)

<u>معلومات عامة:</u>

1. ما هو تخصصك الرئيسي؟
2. ما هو أعلى مؤهل دراسي تحمله في الإحصاء؟ من أين (الجامعة والدولة)؟
3. ماهي مدة خبرتك في تدريس الإحصاء للطلاب الغير إحصائيين في هذه الجامعة؟

<u>المقابلة:</u>

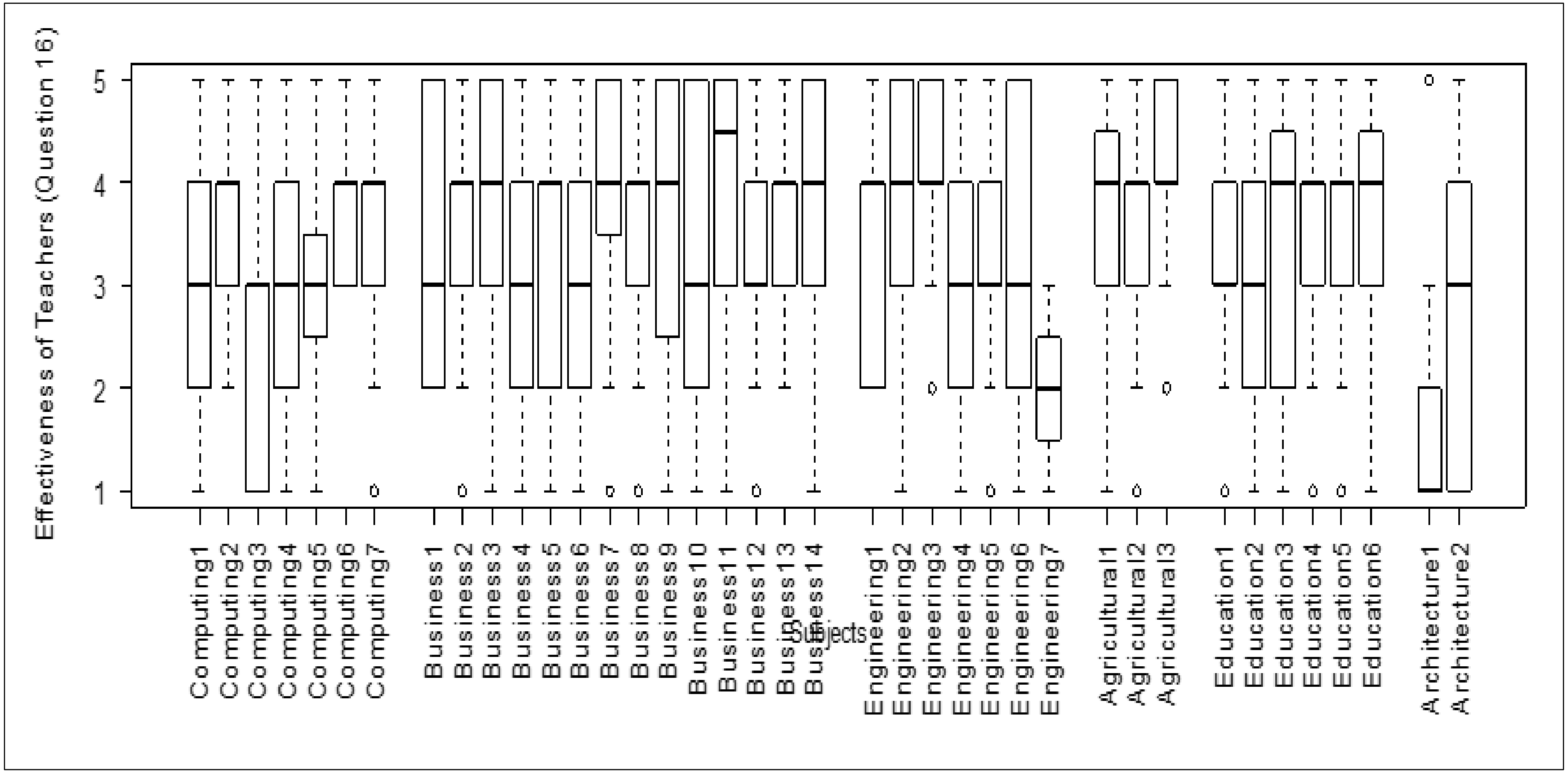
4. ما هي طرق التدريس الرئيسية التي تستخدمها في مقررات الإحصاء للطلاب غير المتخصصين؟
5. ماهي أساليب التقييم التي تستخدمها في مقررات الإحصاء للطلاب غير المتخصصين؟
6. ماهي أهدافك الرئيسية في تدريس الإحصاء للطلاب غير المتخصصين؟
7. كيف تؤثر هذه الأهداف على تدريسك؟
8. في رأيك، ماهي أهم التطورات في الإحصاء التي كانت في العشرين سنة الماضية؟
   - كيف تغيرت مقررات الإحصاء في جامعتك لتعكس هذا التطور؟
   - متى سيكون تقييم مقررات الإحصاء التالي/القادم؟
9. هذا الرسم البياني يوضح إطار PCAI للتحقيقات الإحصائية. هل تقدم هذا الإطار للطلاب غير المتخصصين؟

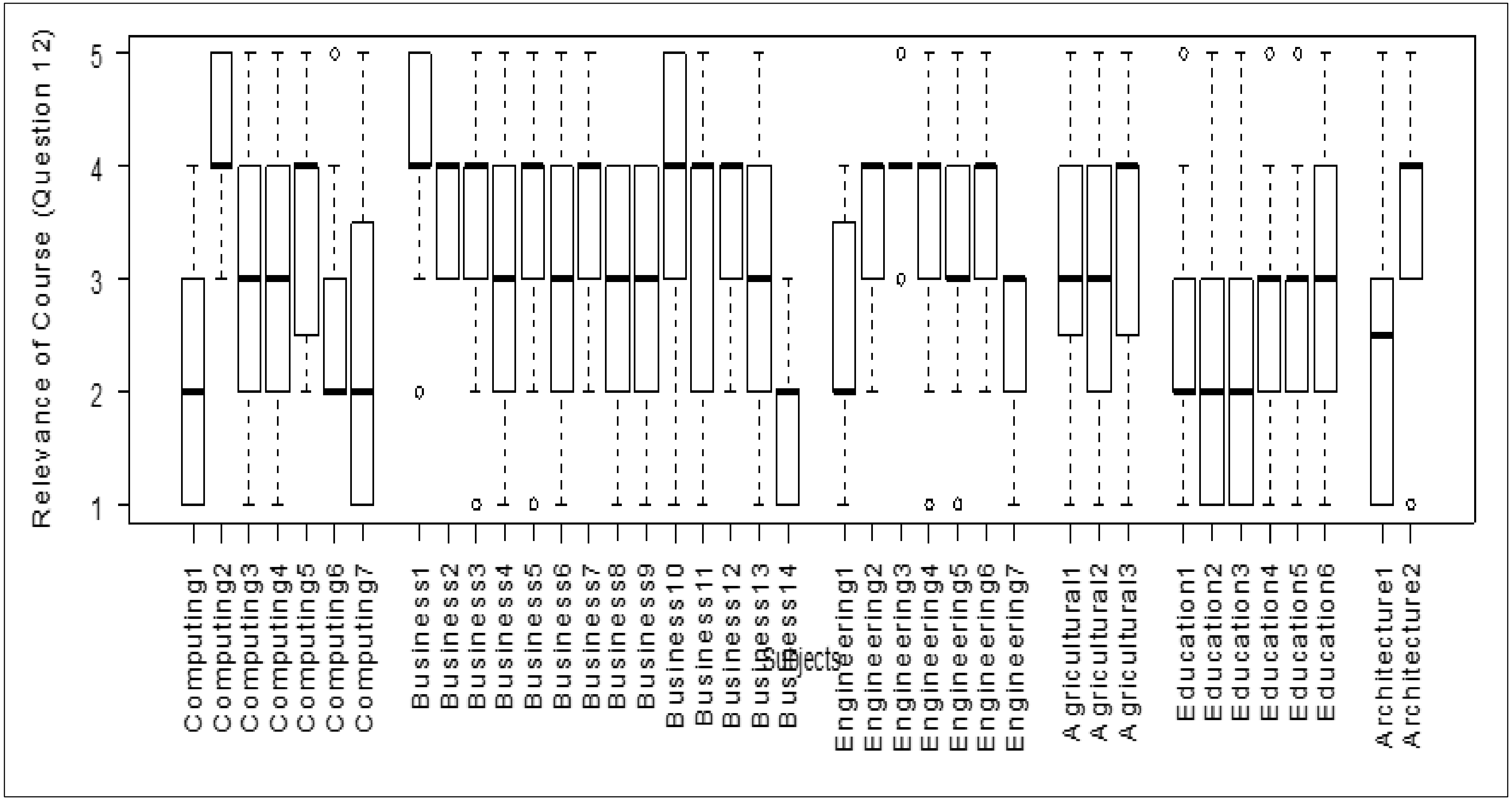
   @ إذا كانت الإجابة (نعم): ماهي الفائدة التي وجدتها من هذا الإطار؟

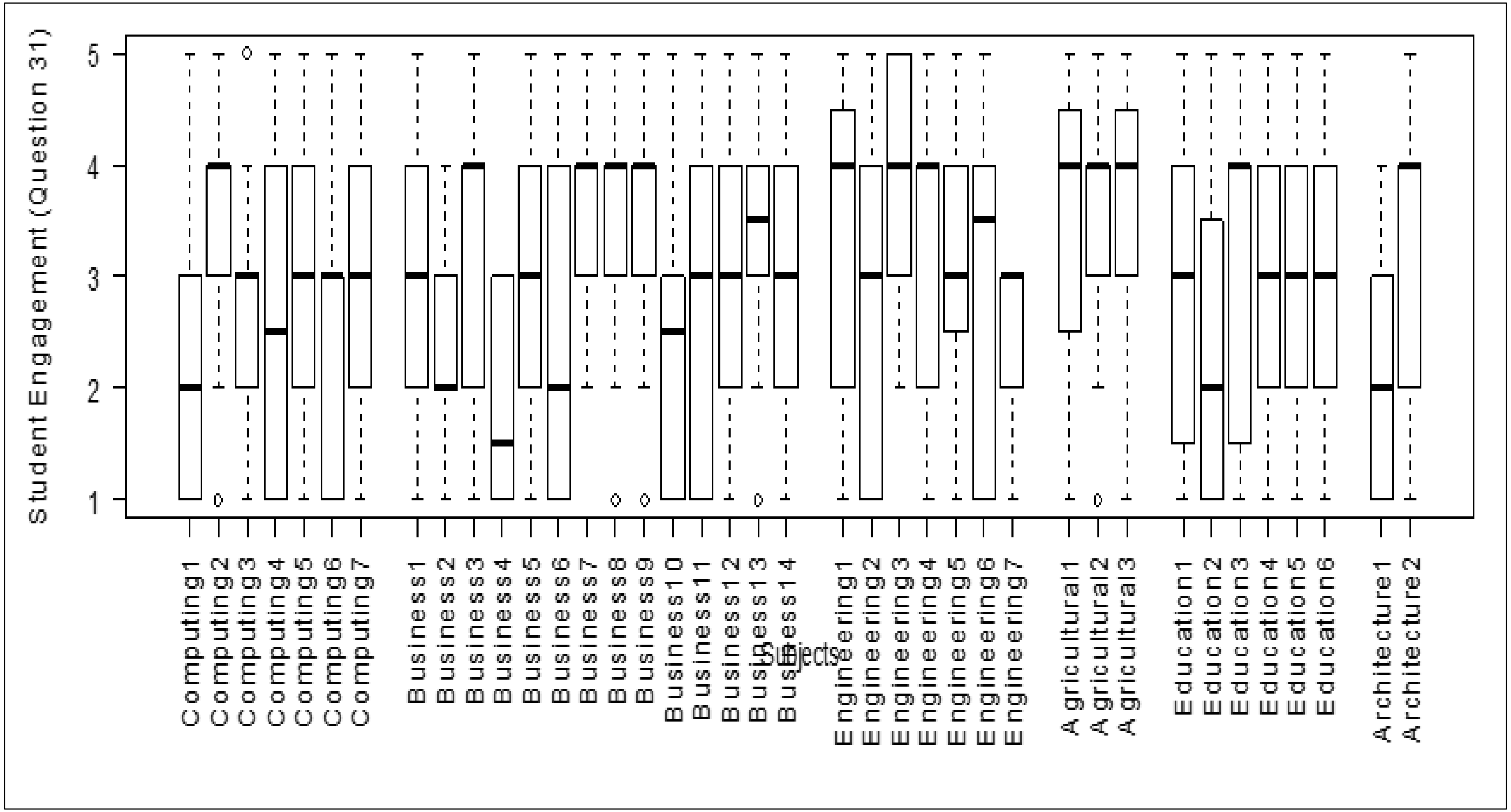
   @ إذا كانت الإجابة (لا): ماهي الفائدة التي تعتقدها عندما تقدم هذا الإطار في تدريسك؟
10. تدريس الإحصاء قد تأثر بشكل كبير من استخدام التكنولوجيا. على سبيل المثال استخدام البوربوينت في العرض، توجيه الطلاب لاستخدام اليوتيوب والمصادر على الشبكة الالكترونية وكذلك استخدام البرامج الإحصائية في تدريس الإحصاء.
    - هل تستخدم التكنولوجيا في تدريس الإحصاء للطلاب غير المتخصصين؟

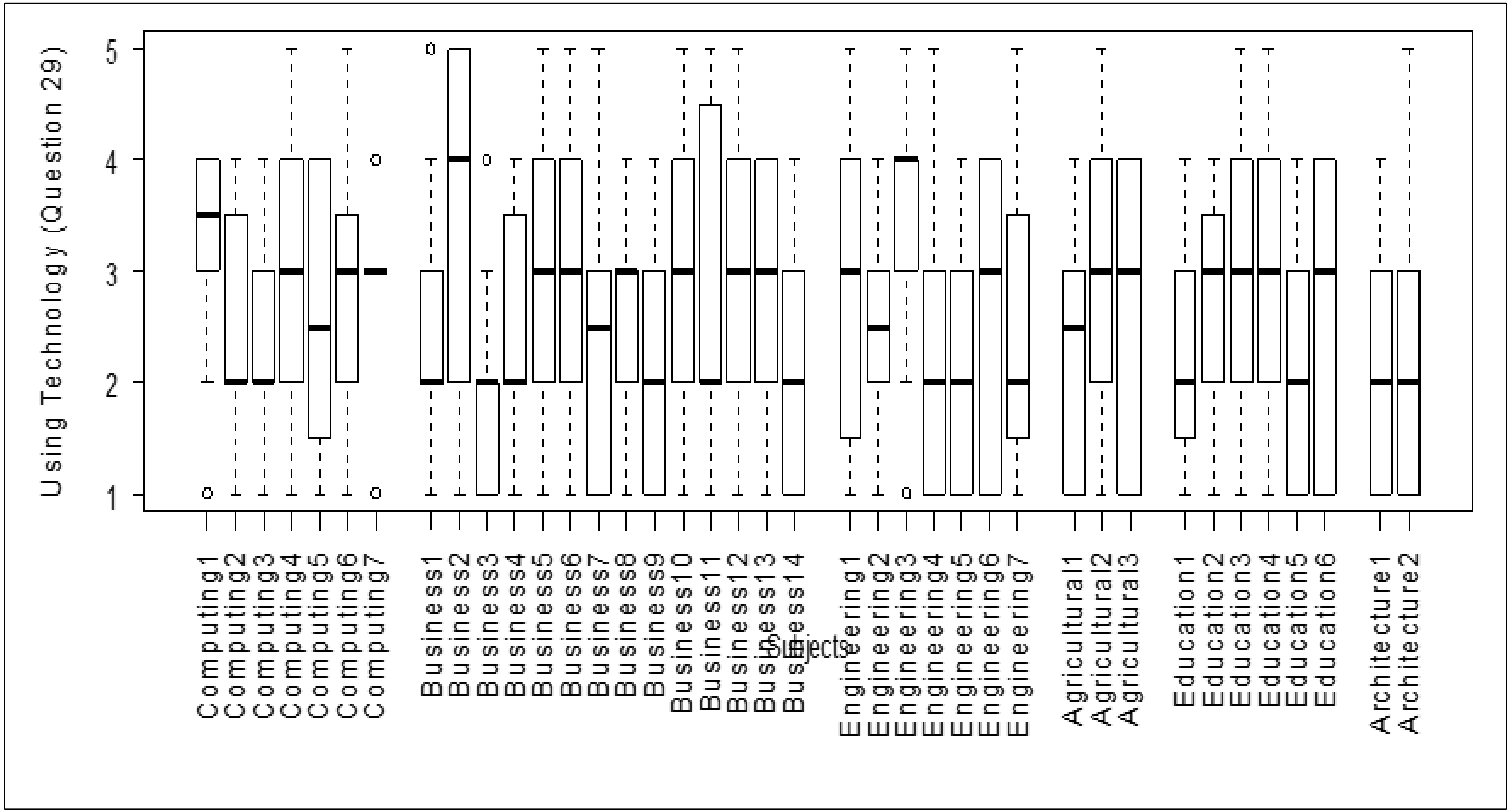
      إذا كانت الإجابة (نعم): هل بالإمكان أن تحدثني قليلاً عن كيفية استخدامك للتكنولوجيا في تدريسك؟
    - من خلال خبرتك، ماهي أهم التحديات لاستخدام التكنولوجيا في مقررات الإحصاء؟
11. كيف من الممكن أن تؤثر محدودية مهارات اللغة الإنجليزية لبعض الطلاب السعوديين في تعلمهم الإحصاء؟
12. ماهي أهم التحديات التي واجهتك في تدريس الإحصاء للطلاب غير المتخصصين؟ كيف تتغلب على هذه التحديات؟
13. إذا كنت تستطيع إحداث بعض التغييرات المقترحة تجاه تدريس الإحصاء للطلاب غير المتخصصين في جامعتك، ماهي التغييرات التي سوف تقترحها؟
14. هل لديك أي خبرة في تدريس مقررات الإحصاء بأي مكان آخر؟
    - إذا كانت الإجابة (نعم): أين؟ كم المدة؟ كيف تختلف عن خبرتك في تدريس الإحصاء في هذه الجامع

Appendix K. Box plot of questions scores for participants from different academic departments




Relevance of Course (Question 12)
1
2
3
4
5
Computing1
Computing2
Computing3
Computing4
Computing5
Computing6
Computing7
Business1
Business2
Business3
Business4
Business5
Business6
Business7
Business8
Business9
Business10
Business11
Business12
Business13
Business14
Engineering1
Engineering2
Engineering3
Engineering4
Engineering5
Engineering6
Engineering7
Agricultural1
Agricultural2
Agricultural3
Education1
Education2
Education3
Education4
Education5
Education6
Architecture1
Architecture2
Subjects


Student Engagement (Question 31)
1
2
3
4
5
Computing1
Computing2
Computing3
Computing4
Computing5
Computing6
Computing7
Business1
Business2
Business3
Business4
Business5
Business6
Business7
Business8
Business9
Business10
Business11
Business12
Business13
Business14
Engineering1
Engineering2
Engineering3
Engineering4
Engineering5
Engineering6
Engineering7
Agricultural1
Agricultural2
Agricultural3
Education1
Education2
Education3
Education4
Education5
Education6
Architecture1
Architecture2
Subjects


Using Technology (Question 29)
5
4
3
2
1
Subjects
Computing1
Computing2
Computing3
Computing4
Computing5
Computing6
Computing7
Business1
Business2
Business3
Business4
Business5
Business6
Business7
Business8
Business9
Business10
Business11
Business12
Business13
Business14
Engineering1
Engineering2
Engineering3
Engineering4
Engineering5
Engineering6
Engineering7
Agricultural1
Agricultural2
Agricultural3
Education1
Education2
Education3
Education4
Education5
Education6
Architecture1
Architecture2