Teacher Assisting and Subject Adaptive Material system: An Arabic Adaptive Learning Environment

By

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(Saudi Arabia)

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DECLARATION

I, Nahla Mohamed Aljojo, declare that the PhD thesis entitled Teacher Assisting and Subject Adaptive Material system: An Arabic Adaptive Learning Environment in Saudi Arabia, results and conclusion embodied in this thesis are my own work.

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ABSTRACT

This thesis reports on research to develop the first adaptive learning system for the Arabic language. The research also develops the first robust translation of the Felder-Soloman Index of Learning Styles (ILS) instrument into Arabic. Literal translation of the ILS applied to a pilot study resulted in lower internal validity in the instrument than found in the English language versions. The research discusses the development of a translation protocol undertaken to improve the validity and internal reliability of the Arabic version of the ILS. The new Arabic version of the Felder-Soloman Index of Learning Styles (ILS) instrument has been applied to two Arabic speaking groups in different Faculties at the King Abdul-Aziz University in Saudi Arabia: The Arts and Humanities Faculty and the Economics and Administration Faculty a total of 1204 students. Further analysis indicates that the Arabic version of the Felder-Soloman Index of Learning Styles (ILS) seems to be an appropriate psychometric instrument to identify learning styles in Arabic speaking communities.

The second major part of the research was to use the Felder-Soloman Index of Learning Styles (ILS) instrument to develop an adaptive learning styles system and evaluate its effectiveness. The Teacher Assisting and Subject Adaptive Material System (TASAM) was tested out on different cohorts of students. Results showed that students taught using the learning style adaptive system performed significantly better in academic achievement than students taught the same material without adaptation to learning style. The feedback of student's Survey overall students seemed to have enjoyed using the TASAM system and there seemed to have been a positive impact on learning performance. The thesis also provides guidance on translations of psychometric instrument and developing adaptive learning system.

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Nahla Mohamed Aljojo
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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

LSI	Learning Style Inventory
WBT	Web-Based Training
CBL	Computer-Based Learning
AHS	Adaptive Hypermedia Systems
AEHS	Adaptive Educational Hypermedia Systems
LSQ	Learning Styles Questionnaire
FSLSM	Felder-Silverman Learning Style Model
MBTI	Myers-Briggs Type Indicator
LST	Silverman Learning Style Theory
ILS	Index of Learning Styles
TASAM	Teacher Assisting and Subject Adaptive Material
CVI	Content Validity Index
CCA	Cross Cultural Adaptation
MOHE	Ministry of Higher Education
ATEE	Association for teacher Education in Europe
CAGR	A Compound Annual Growth Rate
MIT	Massachusetts Institute of Technology
LMS	Learning Management Systems

RNCOS	RNCOS is a leading market research and information analysis company with a global presence
ICT	Information and Communication Technology
FST	Felder-Silverman Theory
FSLSI	Felder-Silverman Learning Style Instrument

RELATED PUBLICATIONS

Aljojo, N., Adams, C., Alkhouli, A., Fitch, T., Saifuddin, H (2009), A Study of the Reliability and Validity of the Felder- Soloman Index of Learning Styles in Arabic, The 8th European Conference on e-Learning, University of Bari, Italy, Academic Publishing International, ISBN 978-1-906638-52-8.

Aljojo, N. & Adams, C. (2009), Adaptive learning based on learning style: E-Learning on a statistics course. In Arlington, the SALT 2009 New Learning Technologies Conference in Virginia, USA.

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Aljojo, N. & Adams, C. (2010), The Teacher Assisting and Subject Adaptive Material (TASAM) System: An Arabic Adaptive learning Environment. In J. Sanchez & K. Zhang (Eds.), Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2010 (pp. 1541-1550). Chesapeake, VA: AACE, Orlando, Florida, USA, ISBN 1-880094-83-5.

Aljojo, N. & Adams, C., Saifuddin, H. & Abdulghaffar. N.A. (2011), Diagnostic Techniques and Procedures for Cross-Cultural Adaptation of Arabic Version Instrument. In J. Sanchez & K. Zhang (Eds.), Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education Honolulu, Hawaii: October 17-21, 2011.

Aljojo, N., Adams, C., Saifuddin, H., & Alsehaimi,Z., (2011), Evaluating the Impact of an Arabic version of an adaptive learning system based on the Felder-Silverman's learning style instrument, The 10th European Conference on e-Learning, University of Brighton, UK 10-11 November 2011, Academic Publishing International.

CHAPTER 1
INTRODUCTION

Adaptive learning systems offer great potential to increase learning support to students, by providing learning material matching individual students' learning systems. However, there are currently no Arabic versions of adaptive learning systems or suitable Arabic versions of a learning style instrument. This thesis presents the development of a validated Arabic learning style instrument (Felder-Silverman Learning Style instrument) and development and testing of an adaptive learning system Teacher Assisting and Subject Adaptive Material System (TASAM) (this is the first adaptive learning system in Arabic).

The introductory chapter provides the background of e-learning, its definition, the growth, advantages and disadvantages of E-learning. Furthermore, this chapter examines e-learning in Saudi Arabia and the objectives of Adaptive Hypermedia System (AHS), as well as explores the types of adaptation, technologies of AHS and the student modelling. The chapter then defines the research aims, the purpose of the study, hypotheses and research methodology, before discussing rationally the significance of the study. The organisation of the thesis is covered in section 1.11 and the five stages of the research are covered in section 1.9 and figure 1.3, which also show how the stages relate to the thesis chapters and published papers of this research.

The major challenge, while conducting this research, was the implementation of English language versions in a non-English speaking and learning environment. The instruments have typically been written in English for a Western culture. There may be difficulties in a literal translation of questions or items as it could result in different meanings. The research so far has resulted in a validated Arabic version of the Felder-Silverman learning style.

This research hopes to develop an adaptive learning system for Arabic speaking communities as well as to provide a firm base for developing an adaptive

learning system based on the Felder-Soloman Index of Learning Styles for non-English speaking students. Also, this research highlights the practicality of creating different learning material to meet the learning styles of individuals, debating issues of evaluation and gauging effectiveness of adaptive learning systems. A formative evaluation is planned to estimate the students' agreement along with a comprehensive evaluation to assess learning efficiency.

1.1 Background of E-learning

Education is very important for an individual to succeed in life. It is a goal that all strive to achieve, whether it be at a relatively low or high level. With education, great advances can be achieved, such as an improved economy. Education is an excellent investment; with greater education, a higher wage normally follows. Those seeking greater education, however, should not need to sacrifice family obligations and a steady career for this cause.

As a result of the development of computers, a new type of education system known as e-learning has emerged, which allows anyone to access its information from any computer via the Internet. This is why e-learning in the developed world has become a great success. Following the introduction of e-learning, students living in small towns can now pursue a degree by accessing the learning provided by a university from the comfort of their own home. This concept enables people to obtain degrees from some of the top universities, such as Harvard and Stanford, despite the physical distances between the two parties (Mirza, 2007).

Computers play a big role not only in learning but education as well. The role of computers in education varies dramatically. Information technology (IT) is used as both tool and medium in education. A report by the Association for Teacher Education in Europe (ATEE) (Rhys Gwyn, 1986; Vijayalaxmi Sirohi, 2007) lists tools for six categories: thinking (problem-solving tools); organising information (text processing and document preparation); guided discovery learning (simulation systems, educational games); teaching and learning the tutorial software (tutorial software is designed to introduce the learner to new skills and concepts); and drill

and practice software (drill and practice software is designed to reinforce known skills).

Rosenberg (2001) summarised the existing definitions of e-learning and came up with three main criteria, which can be used to determine whether a specific form of learning can be considered e-learning.

According to Rosenberg, the first and most important feature of e-learning is that it is networked. It encompasses, therefore, all the benefits of an interconnected multi-user environment, including timely feedback, instant updates, ubiquitous retrieval and the possibility to share information with peers. In line with this criterion, learning programmes on CD-ROMs or DVDs are per se not classified as e-learning. However, if a programme is a "hybrid", which means its main components are stored on CD or DVD, but it also sends and receives data over the Internet, it could then be considered to be e-learning.

The second attribute of e-learning is that it is accessible via a standard Internet browser on a standard personal computer. The question of how the standards are defined is debatable and dependent on the current state-of-the-art in software and hardware. The third and last attribute of e-learning is that it extends traditional paradigms of training. This criterion serves the purpose of distinguishing e-learning from other common acronyms in the field

The main advantage of e-learning over traditional teaching is the fact that it can very easily be adapted to suit a learner's needs. Adaptive learning systems adapt the educational content and presentation according to the specific characteristics of the learners (Jonassen & Wang, 1990; Costa et al., 1991; Beaumont, 1994). The aim is to provide a tailored course which is similar to the one that could be achieved with a private tutor. However, in order for a learning system to provide adaptivity, the profiles of the learners need to be known. The learners' profiles are obtained through the process of 'student modelling' and the profiles called 'student models' (Hume, 1995; El-Sheikh & Sticklen, 1998; Zhou & Evens, 1999; Lu et al., 2005; Nykänen, 2006). Other advantages of e-learning include eliminating travel time between home and university or study centre. With time saving comes cost saving. These costs can

include fuel, food and drink bought on campus, and other such commodities which can amount for a significant percentage of a student's budget.

In addition, some students prefer the seclusion and private nature of the e-learning environment. For students who do not like to interact in classroom discussions, or who fear being called upon by the instructor to answer questions, e-learning, in comparison, can provide a safe fear-free environment. Also, for students who are self-motivated and self-initiated, e-learning constitutes an environment of higher knowledge capture and higher content retention (Turban, et. al., 2006).

Though the benefits of e-learning are many, there are a varied number of disadvantages. The greatest disadvantage is the nonexistence of the human factor. Education is not just acquiring knowledge; educating the young and old alike involves personality development. This aspect is not present in e-learning. Even though human communication can be readily achieved through audio or video based web-conferencing programmes, it does not provide the same effect as traditional teaching.

E-learning educational methodology, being highly technical, has high initial costs and also an ongoing maintenance cost. These costs, however, are only marginal; as more and more students begin to use the course, the cost per student drops significantly. Another drawback usually occurs with the understanding of the technicality of the mechanism; for example, the faculty or students may have difficulty in dealing with the technology. This does happen when there is a lack of training for the teaching faculties, and a high rate of computer illiteracy amongst the students. It requires training for both teacher and student to improve their computer skills to make the best use of this educational method. Some other important drawbacks deal with the fact that not all students are good self-motivators, and hence, they may easily fall behind. This may lead to higher student dropout rates compared with traditional teaching (Turban et al., 2006).

1.2 Growth of E-learning

Across all segments, the market for these electronic learning products and services grew to $18.2 billion in the United States in 2010. That overall figure is

projected to climb to $24.2 billion in 2015, according to Ambient Insight's latest forecast; a relatively modest 5.9 percent Compound Annual Growth Rate comparable with that of Western Europe but lagging far behind Asia (at nearly a 30 percent five-year a compound annual growth rate (CAGR) from 2010 to 2015), Eastern Europe (nearly 25 percent CAGR), Latin America (about 18 percent CAGR) and Africa (roughly 17 percent CAGR). Ambient also believes that at the current rate of growth, Asia will propel itself to become the second largest consumer of this type of product by 2015, just behind North America (www.learn2empower.blogspot.com).

The Saudi Ministry of Higher Education (MOHE), up to the day of writing, is yet to approve international university degrees earned through distance learning. The lists of universities whose degrees are rejected when taken through distance learning include many prestigious universities such as Massachusetts Institute of Technology (MIT), Harvard and Stanford in the United States (USA), and Oxford in the United Kingdom. What does being rejected mean? It means qualifying with that degree limits the opportunity to secure a government job. Moreover, with an internationally earned degree you cannot pursue postgraduate education in Saudi Arabia. For many Saudi students who are interested in pursuing degrees from international universities, but cannot travel to other countries as a result of financial or family obligations, e-learning could be an excellent alternative. Unfortunately, the MOHE declares that in order to approve a degree from any international university, you must conclusively prove that your time was dedicated to studying on a full-time basis, while residing in the country where your degree was earned (Mirza, 2007). Under this rule, e-learning does not qualify.

Based on additional MOHE regulations, any student hoping to gain admission into a PhD programme in a Saudi university must also abandon his or her job. This appears to be a ridiculous request, especially since most of the students in this situation are likely to have a stable career and a family to support. By contrast, over 50% of students in the USA are working students (Hiltz & Turoff, 2005).

The Saudi Ministry of Higher Education (MOHE) has recently established a National Centre for E-Learning and Distance Learning. This centre aims to aid the creation of electronic educational material, and allows faculty members of any local university to create e-courses through its own learning management systems (LMS) called Jusur (Mirza , 2007). Many public and private universities and Faculties such as the King Fahad University for Petroleum and Minerals in Dhahran, the Prince Mohammed bin Fahad University in Dammam and Effat Faculty in Jeddah have already started establishing e-learning as a method for improving the educational experiences of their students. King Saud University has also recently started an ambitious plan to provide e-learning facilities to its students.

A new research report by a leading market research and information analysis company with a global presence (RNCOS) shows the Saudi Arabia country has had massive growth in the e-learning market. The size of the e-learning market in the country is anticipated to grow at a CAGR of around 32 percent during 2008-2014 and the market will reach around US$ 670 million in 2014. The dispersed layout of the educational infrastructure in Saudi Arabia has proved to be advantageous for companies offering e-learning courses and solutions. Growth is also backed by the work of the Saudi Ministry of Education for the integration of Information and Communication Technology (ICT). The future demand for e-learning modules will be driven by the entry of a large number of companies and rising investments by existing players. With higher education, the medical and technical education sectors are set for massive developments. Student enrollment in these fields will increase in the future and create huge market potentials for public and private sectors to develop new higher learning institutions, in order to cater for amplifying demand. Additionally, the report describes key factors that make Saudi Arabia a higher education sector highly lucrative for private players looking to enter the market (www.sogroop.com).

1.3 Adaptive Hypermedia Systems (AHS)

Ted Nelson was one of the pioneers of hypertext and defined it as a combination of natural language text with the computer's capability for interactive branches (Conklin, 1987). In other words, hypertext can be seen as non-sequential text, which is connected by hyperlinks. Hypermedia extends the concept of hypertext by media elements such as graphics, audio and video, rather than text-only presentations (Graf, 2007).

The aim of adaptive hypermedia systems is to provide hypermedia content that fits the individual needs of the users. By definition, "hypertext and hypermedia systems…reflect some features of the user in the user model and applies this model to adapt various visible aspects of the system to the user. In other words, the system should satisfy three criteria: it should be a hypertext or hypermedia system, it should have a user model, and it should be able to adapt the hypermedia using this model" (Brusilovsky, 1996, p. 88; Graf, 2007).

A clear distinction has to be made between adaptable (also called customisable) and adaptive hypermedia, which together comprise personalised hypermedia. In either case the user plays a central role and the ultimate goal is to offer a personalised system. In this context, adaptation is defined as the concept of making adjustments in an educational environment in order to accommodate individual differences. Several levels of adaptation can be distinguished, depending on who takes the initiative in the adaptation: the learner or the system (Kay, 2001).

The concept of 'adaptation' or 'personalisation' is an important issue in research for learning systems. The whole spectrum of the concept of adaptation in computer systems is illustrated below, in figure 1.1 (Brusilovsky, 1996; Patel & Kinshuk, 1997; Magoulas et al., 2003). The difference is in the way the adaptation is performed:

- Allowing the users to change certain system parameters and adapt their behaviour accordingly, thus providing student control, is called adaptable system. Adaptable hypermedia systems do not change the user profile unless the user explicitly updates it.

- Systems that adapt to the users automatically, based on the system's assumptions about the user needs providing student control are called adaptive. An adaptive hypermedia system thus works "in the background", without asking the user for specific input on his/her goals, preferences or knowledge.

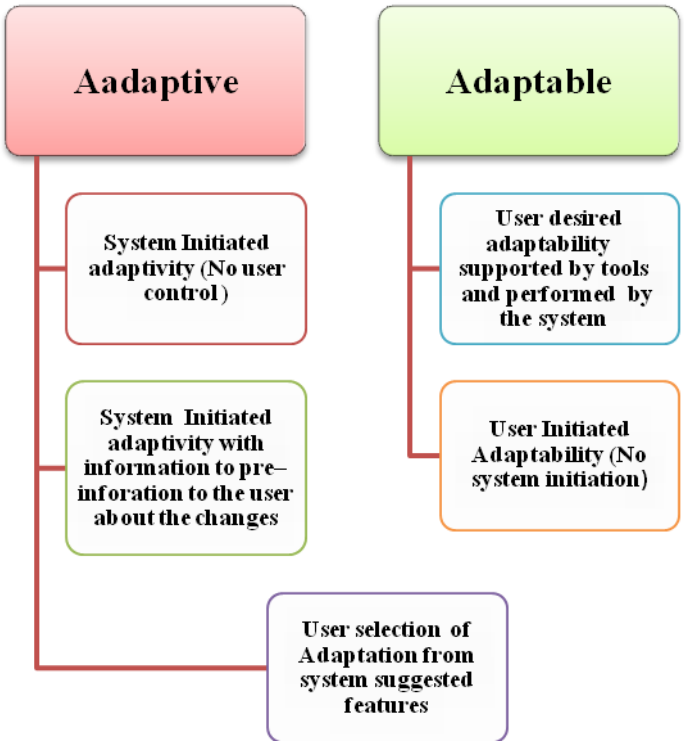

Figure 1.1: Spectrum of the adaptation concept (Brusilovsky, 1996; Patel & Kinshuk, 1997; Magoulas et al., 2003).

1.4 Technologies of Adaptive Hypermedia Systems

Several adaptive and intelligent technologies have been applied to introduce adaptation in Adaptive Educational Hypermedia (AEH) systems. There are two main ways in which adaptation can be performed in adaptive hypermedia systems: 'adaptive navigation' and 'adaptive presentation'. These are summarised in Figure 1.2 and further explored in detail (Brusilovsky, 2001).

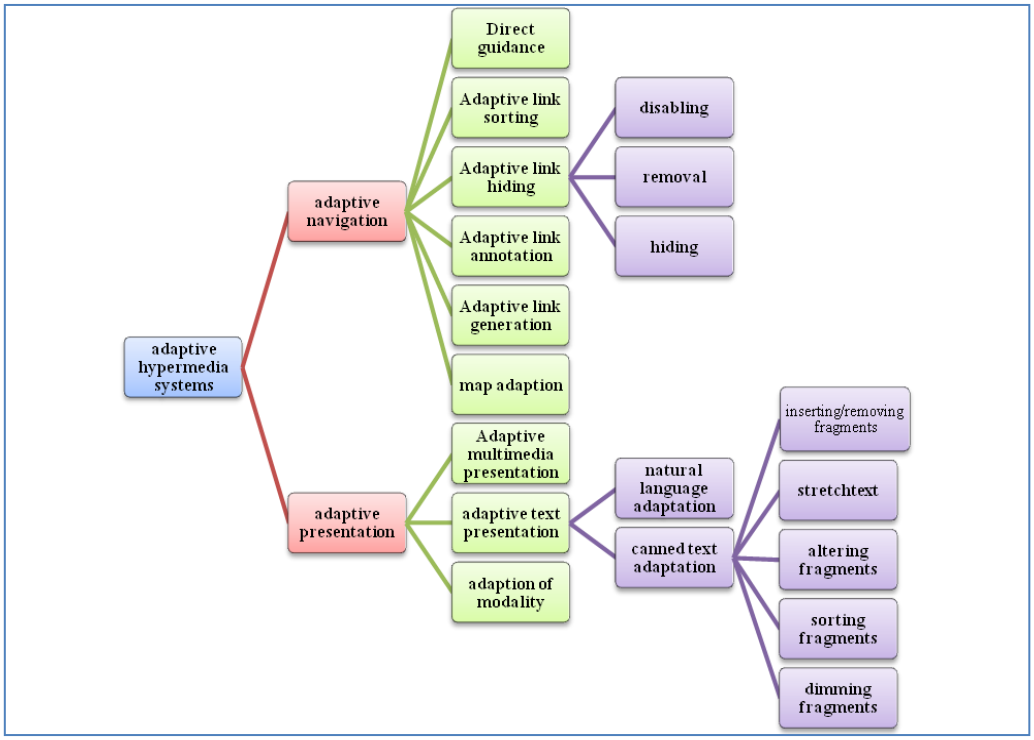

Figure 1.2: Taxonomy of adaptation techniques in AH taken with permission from Brusilovsky (2001) and updated from Brusilovsky (1996)

1.4.1 Adaptive Presentation

Adaptive presentation technology adapts the content in each hypermedia node (page) to a specific student's goals, knowledge and other information stored in the student model. In a system with adaptive presentation, the pages are not static but adaptively generated or assembled for each user. A further technique in providing adaptation to the user is in the form of content representation. Originally carried out mostly through variations in adaptive text presentation, this now includes adaptive multimedia presentation and adaptation of modality. Adaptive multimedia presentation is related to, but different from, adaptive modality. The former suggests that different types of multimedia (e.g. images) can be adapted to user characteristics, as seen in techniques developed by Maybury (1993) and André and Rist (1996).

However, these procedures have not been fully implemented in large hypermedia systems. Adaptive modality refers to the distinction between different

media (still images, video, audio, etc) and how each type can often be used to represent similar information. Thus, certain media types or subsets of media can be presented to the user, according to the characteristics of the user model. These characteristics might include user preferences or learning style.

There are many techniques for adaptive text presentation since this was the focus of much early adaptive hypermedia research. Such an approach can be subdivided into two groups: natural language adaptation and canned text adaptation. Canned text adaptation is subdivided into five main types: inserting/removing fragments; stretch-text; altering fragments; sorting fragments; and dimming fragments (Brusilovsky, 2001).

Fragments of text might be inserted or removed depending on the rules specified by the user model (for example, if they appropriate for the user's knowledge level or not). Stretch-text – an idea originally conceived by Nelson (1967) – allows text to be dynamically extended or shrunk so that either more or less detailed information is shown on screen, hence a more advanced student need not be shown basic material. Text may be altered according to user profile (for example, to give different examples based on a user's occupation) or sorted differently so most relevant or appropriate text is shown at the top of the page. Fragment dimming, akin to link dimming, can be used to give a visual cue on the appropriateness of a specific portion of text.

1.4.2 Adaptive Navigation

The adaptive navigation support technology is to assist the student by changing the appearance of visible links. For example, an adaptive hypermedia system can sort, annotate, or partly hide the links of the page to make it easier to choose where to go next. Adaptive navigation support shares the same goal with curriculum sequencing - to help students find an "optimal path" through the learning material. At the same time, adaptive navigation support is less directive and more "co-operative" than traditional sequencing: it directs students while leaving them the choice of the next knowledge item to be learned and next problem to be solved (Brusilovsky, 1996, 2001). There are four kinds of link presentation that can be

adapted: Local non-contextual links, Contextual links, Links from index and content pages, and Links on both local maps and global hyperspace maps. The ways in which these links can be adapted can be divided into six categories: direct guidance; adaptive link sorting; adaptive link hiding; adaptive link annotation; adaptive link generation; and map adaptation (Brusilovsky, 2001).

1.5 Student Modelling

The student module builds and updates all relevant data about the user. The expert module is responsible for the domain knowledge (i.e. the facts and rules of a particular domain) and for the internal representation of the domain knowledge in the system (Brusilovsky, 1994).

The student model plays a key role in an adaptive educational hypermedia system (AEHS). It includes all relevant information that the system has gathered about the student. This information is then used to adapt a learning system. This process of building and updating the student model is called student modelling. While Self (1994) provided a definitive description of student modelling from a point of view of the formal techniques, Brusilovsky (1994, 1996) classified student models and techniques for student modelling based on existing systems.

In a student model, different kinds of information can be included. Brusilovsky (1994) stated two groups, namely, models of course knowledge and models of individual subject-independent characteristics. Both are different in terms of the way the information is presented and the method in which it is constructed and applied. While initial investigations about student modelling focused on models about the course knowledge, more and more research is now done on modelling the individual characteristics of learners such as learning styles (Graf, 2007).

1.6 Research Aim

This research explores how to improve the learning process in an Arabic learning environment by adapting course content presentation to student learning styles in multi-platform environments such as PC. A framework has been developed to model

comprehensively students' learning styles and present the appropriate subject matter, including the content, format, media type, and so on, to suit individual learning style.

Also, the aim of this research is to discuss the practicality of presenting different learning material to meet the learning styles of individuals, and to consider issues of evaluation and how to measure effectiveness of adaptive learning systems. A formative evaluation is planned to evaluate the student satisfaction along with summative evaluation to assess learning effectiveness.

1.7 Purpose of the Study

Educational research informs us "one size does not fit all" (Reigeluth, 1996), and that the learning characteristics of students differ (Honey & Mumford, 1986). It suggests also that students have different preferred methods of learning (Riding & Rayner, 1998). Research has shown that it is possible to diagnose a student's learning style. Adapting the work to suit the style he or she is most comfortable with makes learning an easier and more efficient process (Rasmussen, 1998).

The adaptive educational systems offer an advanced form of learning environment that attempts to meet the needs of different students (Brusilovsky & Peylo, 2003). In terms of each student, such systems capture and represent various user characteristics such as knowledge, background and traits in an individual learner model. Subsequently, the selected model dynamically adapts the learning environment for each student in a manner that best supports learning.

Typical strategies that could be used to adapt the environment include changing the presentation of content in order to hide information not relevant to the user's knowledge and providing navigation support using annotated links that suggest the most relevant path to follow (de Bra, 2002; Kelly,2005).

However, the individual learners play a central role in traditional as well as technology-enhanced learning. Each learner has individual needs and characteristics such as different prior knowledge, cognitive abilities, learning styles, motivation, and so on. These individual differences affect the learning process and are the reason

why some students find it easy to learn in a particular course, whereas others find the same course difficult (Jonassen and Grabowski, 1993; Graf and Kinshuk, 2007).

Much research has been done into prior knowledge and its influence on learning. Jonassen and Grabowski (1993) concluded that prior knowledge is one of the strongest and most consistent of individual difference predictors of achievement. Although prior knowledge seems to be the key component to a learning style, in comparison with other individual differences, more recently researchers have focused on aspects of personal characteristics such as learning styles, their impact on learning, and also how they can be incorporated into e-learning environments (Graf and Kinshuk, 2007). Considering learning styles, investigations into different educational and psychological theories have been conducted which show that every student has a preferred method of learning.

Furthermore, Felder, for example, pointed out that learners with a strong preference for a specific learning style may have difficulties in learning if the teaching style does not match their learning style (Felder and Silverman, 1988; Felder and Soloman, 1997). From a theoretical point of view, the conclusion can be drawn that incorporating learning styles of students in the learning environment makes learning easier for them and increases their learning efficiency. On the other hand, learners whose learning styles differ from what is presented in their learning environment may experience problems with learning. Adaptive educational systems address exactly this issue.

1.7.1 Research Questions

Investigations regarding generic and specific research questions have been conducted:

1.7.1.1 Generic research questions

1. Which Learning Styles instrument would be appropriate for developing an Arabic adaptive learning system?
2. How can a validated Arabic version of Learning Styles instrument be produced?

3. How can the validated instrument be applied to an adaptive learning system?
4. How can an e-learning environment adapt itself to accommodate individual learning styles?
5. What is the impact on learning performance of the student when the learning materials are matched and mismatched with the learning styles of a student?

As covered in detail in Chapter 3, the Felder-Silverman Learning Style Theory is chosen for this research. The generic research questions 2-5 above are applied to the Felder-Silverman Learning Style Theory. The researcher was able to receive collaboration at the King Abdul-Aziz University in Saudi Arabia to undertake development of an adaptive learning system and to apply it to a statistics course to be used by two faculties. Consequently, further research questions range: 1-2.

1.7.1.2 Specific research questions

1. Do the Arabic students in different faculties have different learning styles?
2. Are Arabic students' responses to a validated Arabic version of the learning style instrument similar to English speaking students' responses?

1.7.2 Objectives

The main target of this research was to construct and evaluate an e-learning environment, which adapts to individual learners. The most significant objectives of this study are:

1. To develop an adaptive learning system for Arabic speaking communities as well as to provide a firm base for developing an adaptive learning system based on the Felder-Soloman Index of Learning Styles for non-English speaking students.
2. To discuss the development of a translation protocol undertaken to improve the validity and internal reliability of the Arabic version of the ILS. This

includes internal consistency reliability, test-retest reliability, and factor analysis.

3. To compare responses to two Arabic speaking groups in different Faculties at the King Abdul-Aziz University in Saudi Arabia: The Arts and Humanities Faculty and the Economics and Administration Faculty.

1.8 Hypotheses

TASAM uses the F-S theory as the educational theory to model individual learning styles. However, the question remains whether the TASAM system positively improves learning performance.

In order to acquire some insight into how the learning environment should change, empirical studies were conducted using TASAM. These studies explored:

- providing material that matched the learning styles of a student to determine whether this would improve the learning performance of a student.
- the effect of the adaptive material according to learning styles of a student on the learning performance of a student.

1.8.1 Hypotheses of Trial Test System (TASAM)

Participants consisted of 80 students from the Arts and Humanities Faculty and consisted of three different groups:

1. Group (A) consisting of 22 students, who were given the chapter covering the T-Test to work through in TASAM. The professor did not explain the chapter (T-Test).
2. Group (B) consisted of 18 students, who were given the T-Test chapter to work through in the TASAM system. A teacher, however, explained the chapter (T-Test).
3. Group (C) consisted of 40 students, who were given teacher explanation of the T-Test chapter (i.e. without using the TASAM adaptive system).

The hypothesis will be covered in detail in Chapters Six and Seven, section 7.4, and mainly covered in Aljojo et al. (2011) and Aljojo and Adams (2010).

H0: group (B) will learn significantly better than group (A).

H1: group (A) will learn significantly better than group (C).

H2: group (B) will learn significantly better than group (C).

1.8.2 Hypotheses of Final Test System (TASAM) – First Semester

Participants consisted of 53 students from the Arts and Humanities Faculty and organised into two groups:

1. Group (D) consisted of 28 students, and four different cases.
    - Group(D), Case 1: students using the TASAM system with no professor explanation of the chapter (Measures of Variability and Correlation)
    - Group(D), Case 2: students not using the TASAM system and only using the professor explanation of the chapter (Central tendency)
    - Group (D), Case 3: students using the TASAM system with professor explanation of the chapter (Measures of Variability and Correlation).
    - Group(D), Case 4: students using the TASAM system with no-professor explanation of the chapter (Correlation)

2. Group (E) consisted of 25 students, and three different cases.
    - Group(E), Case 1: students using the TASAM system with no professor explanation of the chapters (Measures of Variability and Central tendency statistics)
    - Group(E), Case 2: students not using the TASAM system and only using the professor explanation of the chapter (Correlation)
    - Group (E), Case 3: students using the TASAM system with professor explanation of the chapters (Measures of Variability and Central tendency statistics).

The hypothesis will be covered in detail in Chapters Six and Seven (section 7.6) and mainly in Aljojo et al. (2011) and Aljojo and Adams (2010).

H3: Group (D), Case 1 will learn significantly better than Group (D), Case 2

H4: Group (D), Case 1 will learn significantly better than Group (D), Case 3

H5: Group (E), Case 1 will learn significantly better than Group (E), Case 2

H6: Group (E), Case 1 will learn significantly better than Group (E), Case 3

H7: Group (D), Case 4 will learn significantly better than Group (E), Case 2

1.8.3 Hypotheses of Final Test System (TASAM) second Semester

Participants consisted of 30 students from the Arts and Humanities Faculty and organised into one group. The chapters are different, but it is the same group.

1. Group (F) has two different cases.

    - Group (F), Case 1: using the TASAM system with no professor explanation of the chapters (Measures of Central tendency and Measures of Variability).

    - Group (F), Case 2: not using the TASAM system and only using the professor explanation of the chapter (Correlation).

The hypothesis will be covered in detail in Chapters Six and Seven (section 7.8) and mainly in Aljojo et al. (2011) and Aljojo and Adams (2010).

H8: Group (F), Case 1 will learn significantly better than Group (F), Case 2

1.9 Research Methodology

The research methodology will be covered in detail in Chapter Three. However, the research methodology will be addressed within the context of research design, research questions and hypotheses, research design and pilot of study. The overall methodology for the research consisted of:

Stage1:

- Review literature and previous works covering adaptive learning systems. See Chapter Two.
- Choosing an appropriate learning style measurement instrument. See sections 4.3 and 4.5 in Chapter Four.

Stage 2:

- Translating the instrument into Arabic and validating the Arabic version. See sections 4.6, 4.8 and 4.9 in Chapter Four and sections 7.2 and 7.3 in Chapter Seven.
- Identify suitable learning environment and course(s) for developing and testing the system. See sections 5.2.1 and 5.2.2 in Chapter Five.

Stage 3:

- Develop an adaptive teaching taxonomy mapping out electronic media representations of teaching material with learning styles and the teaching strategy for the course(s). See sections 5.2.3 and 5.4 in Chapter Five.
- Design system testing and evaluation mechanisms. See section 6.2 in Chapter Six and sections 7.4 and 7.5 in Chapter Seven.

Stage 4:

- Develop adaptive learning system. See sections 5.2.3 and 5.4 in Chapter Five.
- Apply adaptive learning system with sample groups. See section 6.2 in Chapter Six and sections 7.6 and 7.8 in Chapter Seven.
- Evaluate student and tutor use of the adaptive system. See section 7.7 in Chapter Seven.

Stage 5:

- Evaluate learning performance using the adaptive learning system and make any needed refinements. See Chapter Seven, sections 7.9 and 7.10.

Stages 1 and 2 are mainly covered in Aljojo et al. (2009) and Aljojo and Adams (2009), with Chapter Three providing some background to learning styles and adaptive systems. The Felder and Soloman Index of Learning Styles (ILS) instrument was selected for this study and the translation and conversion process into Arabic consisted of forward then backward translation by independent English-Arabic translators. The resulting Arabic version of the ILS was then evaluated, question by question, by a panel of eight Arabic and English speaking psychologists to ensure consistency of constructs. The final Arabic version of the ILS was applied to just 1024 Arabic speaking undergraduate students and the results checked for

internal consistency and construct validity in line with English versions of the ILS (Aljojo et al., 2010). See figure 1.3.

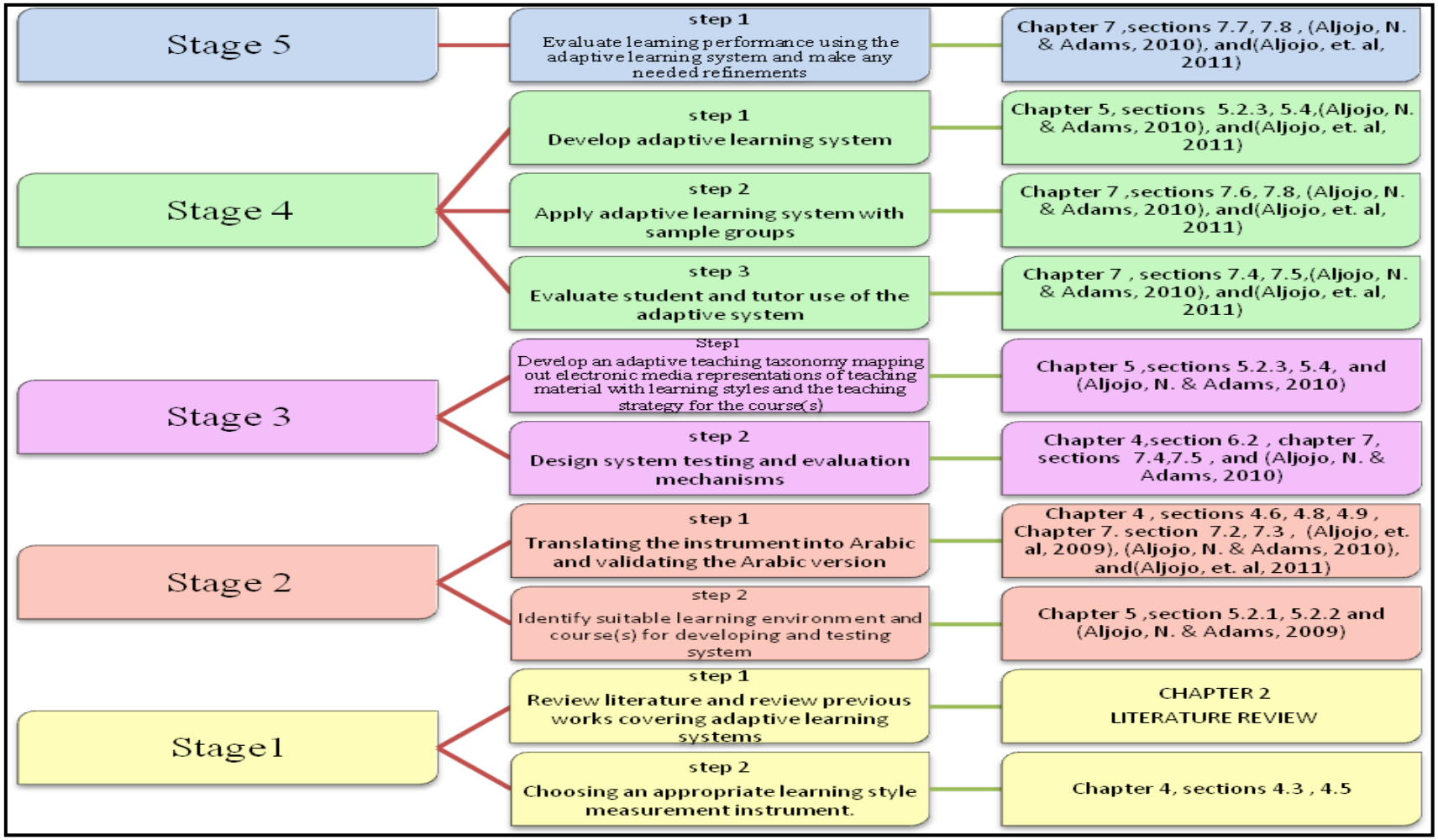

Figure 1.3: Research Methodology

1.10 Rationale and Significance of the Study

Adaptive educational systems that adapt to different learning characteristics offer great opportunities to enhance learning for all types of learners. However, building such systems is not easy and outstanding research issues include how to diagnose relevant learning characteristics and how to adapt the learning environment for different learners. This research suggests that the theory of Arabic version Felder-Silverman learning style is an unexplored dimension in the design of adaptive educational systems, that there is a need for intelligent techniques that can diagnose learning characteristics and that adaptive hypermedia techniques can be used to improve learning performance. This thesis proposes that the Teacher Assisting and Subject Adaptive Material system adaptive educational system addresses these challenges in a novel manner.

1.11 Organisation of the study

This thesis consists of nine chapters, including the introduction chapter (i.e. chapter one). Chapter Two reviews the available literature on adaptive educational system and learning styles theories, the benefits, advantages and limitations. Chapter Three examines the methodology and philosophical approach, research design, data description and research process, and includes a summary. Chapter Four discusses the reliability and validation of the Felder-Soloman index of learning styles in Arabic. In Chapter Five the study reviews TASAM (the Teacher Assisting and Subject Adaptive Material) design. Chapter Six reviews experimental design and evaluation. Chapter Seven provides the results, findings and analysis of the primary data (paper based surveys and experimentation). Chapter Eight is the discussion chapter, and Chapter Nine sets out the conclusion, contribution of the research findings, limitation of the study and general recommendations.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The Internet and the World Wide Web offer an excellent and easy way to get learners in contact with learning resources. The hypermedia form of the educational material in a Web-based teaching system makes learning through it a goal-driven process, in which learners motivate themselves to find alternative ways to solve the problems using different resources from around the world. However, the presentation of the domains is usually the same for every learner, and does not take into account the user's knowledge or learning style preference. This issue should be explored further, especially with web-based instruction, as learners can be easily characterised by their background knowledge, age, experiences, cultural backgrounds, professions, motivations and goals. Learners take the main responsibility of their own learning (Papanikolaou et al., 2002).

Technology enhanced learning solutions offer the potential to provide learning environments that support and acknowledge individual differences. Technology can enable learners to acquire knowledge and skills at a time, place and pace that are appropriate for their own particular circumstances.

There is a vast variety of learners in the world; each person has his or her own learning preference, aims and objectives. Every learner has the right to demand a high quality, personal learning experience. However, as current web-based learning environments offer a 'one size fits all' approach to the delivery of learning materials (every learner is given the same set of resources), the personalised approach to education is sadly lacking from most online systems. Adaptive Educational Hypermedia (AEH) seeks to address this lack. It aims to create new opportunities for learners, whilst also enhancing existing approaches – delivering lessons and courses adapted to the requirements of each learner (Brusilovsky & Peylo, 2003).

In spite of the great amount of Adaptive Hypermedia Systems (AHS) research, there is a lack of literature about the attempts to incorporate learning styles

in adaptive web-based training. The research objective is to fit the student's learning style in order to improve the teaching/learning process. We believe that the dynamic course adaptation to the student learning style improves the process of learning. The student follows the course spending less time and obtaining better learning experience (acquiring knowledge in a comfortable environment) (Paredes and Rodriguez, 2004). In past decades, researchers from different disciplines have sought to define and classify learning styles that help teachers to improve their individualised teaching.

This chapter will shed light on several learning styles models for this research. It will describe the learning styles of different researchers and provide a review of literature that focuses on Adaptive educational hypermedia systems based on the learning styles.

2.2 Learning styles

Learning styles are described by different researchers as:

- Unique behaviours which indicate how a person learns from and adapts to his environment (Gregorc, 1979);
- Preferring one mode of adaptation over the other and taking into consideration that these preferences will not exclude other adaptive modes, but vary from time to time and situation to situation (Kolb, 1981);
- Combination of characteristic cognitive, reflective and psychological factors, which show how a learner perceives, interacts and responds to the learning environment (Keefe, 1979).
- Getting to know the attitude and behavior of an individual will determine the preferred way of his/her learning ability (Honey and Mumford, 1992);
- A coherent whole of learning activities that students usually employ, their learning orientation and their mental model of learning (Vermunt, 1996).

There are several learning style theories used today, which have been introduced widely in educational environments. For example, the Theory into Practice Database (TIP, 2003; Kinshuk and Lin,2003) provides 50 major theories of learning and

instruction, such as Kolb's learning style theory (Kolb and Fry, 1975; Kolb, 1984), Gardner's Multiple Intelligences Theory (Gardner, 1993), Felder-Silverman Learning Style Theory (Felder and Silverman, 1988; Felder, 1993), Litzinger and Osif Theory of Learning Styles (Litzinger and Osif,1993; Kinshuk and Lin,2003) and Myers-Briggs Type Indicator (MBTI) (Briggs and Myers, 1977; Myers and McCaulley, 1985). In recent years, researchers have started considering the learning styles in computer based educational systems. Adaptive hypermedia systems that are based on learning styles provide the option of tailoring the presentation of course material to each student (Carver, Howard, & Lane, 1999).

2.3 Overview of Learning Styles Models

This section describes five commonly used learning style models. The selection of these models is based on Coffield's review (Coffield et al., 2004a), including the theoretical importance in the field, their widespread use and their influence on other learning style models. Additionally, the extent to which the specific learning style is applicable in the field of technologically enhanced learning (e.g. web-based instruction) was an important factor, as well as the potential for the learning style model's use in already established systems. Since this thesis is focused on learning styles rather than cognitive styles, models that measure the cognitive abilities and skills rather than self-reported learning preferences were excluded. Table 2.1 shows the selected learning style models grouped according to the classification by Coffield et al. (2004b) and ordered according to the dependencies of the models among each other.

2.3.1 Personality Types as defined by Myers-Briggs

Myers-Briggs Type Indicator (MBTI) (Briggs Myers, 1962) is a test given to assess personality and important aspects for learning. Whereas other learning style models are based on considerations of MBTI and Jung's theory of psychological types (Jung, 1923), the MBTI distinguishes a person's type according to four types (see table 2.1). The four types are linked to each other and interact rather than being independent, and for a whole understanding of a person's type, the combination of all

four preferences must be considered. The standard version of the MBTI is the 93-item Form M (Myers and McCaulley, 1998).

2.3.2 Constitutionally-based learning styles and preferences

The Learning Styles Inventory (Dunn, Dunn, and Price, 1996) was created for children and has three distinct versions (kindergarten to grade 2, grade 3 and 4, grade 5-12). This inventory consists of 104 questions which use the three-choice or five-choice Likert scale. The Building Excellence Inventory (Rundle and Dunn, 2000) is the current version for adults. It includes 118 questions and uses a five-point Likert scale. A high or low preference for each of the four factors is identified. See table 2.1.

2.3.3 Learning approaches and strategies

A researcher within this family refers to different personalities and relatively fixed cognitive characteristics. This causes a different preference for styles, strategies and approaches. An approach derived from perceptions of a task and cognitive strategies that learners might use to overcome it. "Their view of approaches and strategies as opposed to styles takes into account the effects of previous experiences and contextual influences" (Coffield et al., 2004).

2.3.3.1 Pask's model

A well known and influential researcher within this field has been Pask (Pask, 1976), who argues that there are clear and categorisable differences between students' learning strategies, such as the holist strategy in which the student attempts to work from a broad view of the task, while relating to personal experience and knowledge. The opposite strategy, that of the serialist, views students as building understanding from the small details within a task instead of using a more widespread approach. Pask makes this distinction between the two styles from a theory of learning derived from what he calls 'a conversation between two representations of knowledge'. In other words, he identified two distinct strategies (See table 2.1).

Pask created two tests in order to measure the two distinct strategies: the Spy Ring History Test and the Smuggler's Test. Although Pask's work has been influential in this family of learning styles, both in concepts and methodology, his two tests have not been widely used outside these scientific disciplines due to their lack of reliability (Coffield et al., 2004).

2.3.3.2 Vermunt's framework for classifying learning styles

Vermunt's Inventory of Learning Styles (ILS) is a 120-item self-rating instrument. Vermunt's model is focused on higher education (university level) and is in wide use in Europe. By focusing his attention on higher education, Vermunt has been able to create a reliable self-assessment tool, but due to this, its relevance is unknown in other contexts, such as problem-based learning, vocational education, etc. For Vermunt, the "approach to learning" and the "learning style" are one and the same. Within Vermunt's framework, four learning styles are identified (Coffield et al., 2004) (see table 2.1).

2.3.4 The cognitive structure family

In this section we discuss two models from the cognitive structure family: Witkin's Field-dependence versus field-independence dimension (FD versus FI) and Riding's model.

2.3.4.1 Witkin's dimension – field-dependence versus field-independence

The construct of FD/FI measured in the tests broadened to include perceptual and intellectual problem solving. It is used to describe how much a learner's comprehension of information is affected by the surrounding perceptual or contextual field (Witkin et al., 1977). Researchers draw several conclusions about the strategies and approaches taken by FD and FI individuals (see table 2.1).

2.3.4.2 Riding's model of cognitive styles

An example of a "unitary" position is Riding and Cheema's (Riding and Cheema, 1991) point of view. They assessed more than 30 learning style models, and

concluded that all 30 models fall into two distinct dimensions: ‘basic cognitive styles’ and ‘meta-styles’ (see table 2.2 based on Riding and Rayner, 1998).

2.3.5 Flexibly stable learning preferences

Coffield's report places the models where authors consider that learning style is not a fixed trait, but “differential preference for learning, which changes slightly from situation to situation. At the same time, there is some long-term stability in learning style” (Kolb, 2000).We present here Kolb's Learning Style Inventory (LSI), Honey and Mumford's Learning Styles Questionnaire (LSQ) and the Felder-Silverman model.

2.3.5.1 Kolb's Learning Style Inventory (LSI)

The learning style theory by Kolb (1984) is based on the Experiential Learning Theory (Kolb, 1984), which attempts to recreate the learning process and simulates the role of experience in the process. Using this theory, learning is seen as a four-stage cycle. Concrete experience is the basis for observations and reflections. These observations are used to form abstract concepts and generalisations, which again act as a basis for testing implementations of concepts in new situations. Testing implementations results in solid experience, which closes the learning cycle. According to this theory, learners need four abilities for effective learning:

a) Concrete Experience abilities
b) Reflective Observation abilities
c) Abstract Conceptualisation abilities
d) Active Experimentation abilities.

The current version of LSI (Kolb and Kolb, 2005) uses a forced-choice ranking method to assess an individual’s preferred modes of learning (Concrete Experience, Reflective Observation, Abstract Conceptualisation and Active Experimentation). Learners are given 12 sentences to complete about their preferred way of learning. Each sentence has four possible endings, and the learners are asked to rank each ending on how well it describes their method of learning (4 = most like you; 1 = least like you). The results of the LSI show which of the four modes the

individual is most inclined to. In addition, their score for the active/reflective and concrete/abstract dimensions can be extrapolated from the results of the LSI, which again lead to the preferred type of learning style (see table 2.1).

2.3.5.2 Honey and Mumford's Learning Styles Questionnaire (LSQ)

The learning style model by Honey and Mumford (1982) is based on Kolb's Experiential Learning Theory (for example, Kolb, 1984) and is a further development of the four types of Kolb's learning style model (Kolb, 1984). In Honey and Mumford's learning style model the types are called: Activist (akin to Accommodator), Theorist (akin to Assimilator), Pragmatist (akin to Converger) and Reflector (akin to Diverger). The Learning Style Questionnaire (LSQ) is a self-report inventory which identifies learning styles according to the Honey and Mumford learning style model. Along with its manual, it was initially developed in 1982 (Honey and Mumford, 1982), revised in 1992 (Honey and Mumford, 1992), replaced in 2000 (Honey and Mumford, 2000) and then re-revised in 2006 (Honey and Mumford, 2006). There are at present two versions of the LSQ, one with 80 items and the other with 40 items (See table 2.1).

2.3.5.3 Felder-Silverman Learning Style Model

In this section we present the Felder-Silverman learning style model (FSLSM). In the Felder-Silverman learning style model (FSLSM) (Felder and Silverman, 1988), learners are characterised by values on four dimensions. These dimensions are largely based on well established dimensions in the field of learning styles and can be viewed and analysed separately from each other. They show how learners prefer to process (active/reflective), perceive (sensing/intuitive), receive (verbal/visual) and understand (sequential/global) information. Table 2.1 summarises learning environment preferences of typical learners from each of the four dimensions of the Felder-Silverman model.

The Index of Learning Styles (ILS), developed by Felder and Soloman, is a 44-item questionnaire for identifying the learning styles according to FSLSM. As mentioned earlier, each learner has a personal preference for each dimension. These

preferences are expressed with values between +11 to -11 per dimension, with steps +/-2. This range comes from the 11 questions that are posed for each dimension. When answering a question, for instance, with an active preference, +1 is added to the value of the active/reflective dimension, whereas an answer for a reflective preference decreases the value by 1. Therefore, each question is answered either with a value of +1 (answer *a*) or -1 (answer *b*). Answer *a* corresponds to the preference for the first pole of each dimension (active, sensing, visual, or sequential), answer *b* to the second pole of each dimension (reflective, intuitive, verbal, or global) (see figure 2.1).

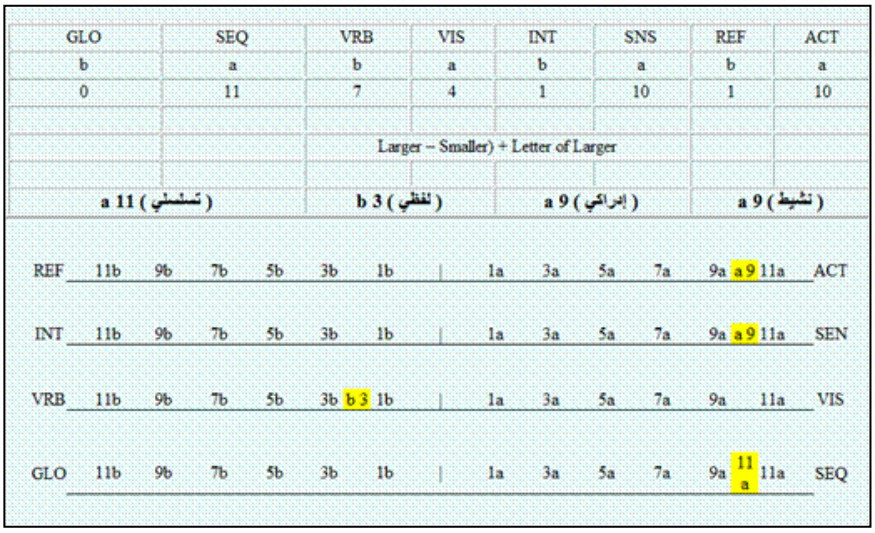

Figure 2.1: Screenshot of the result of the questionnaire

Table 2.1: Families of Learning styles (LS) as organised in Coffield's report

Learning styles families	Learning styles models	Dimensions or Types
Constitutionally-based learning styles	Dunn and Dunn model (Dunn, 2003a)	• Environmental: this strand incorporates individuals' preferences for the elements of sound, light, temperature and furniture or seating
		• Emotional: focuses on students' levels of motivation, persistence, responsibility and need for structure.
		• Sociological: addresses students' preference for learning alone, in pairs, with peers, as part of a team, with either authoritative or collegial instructors, in a variety of ways or in routine patterns.
		• Physiological: examines perceptual strengths (visual, auditory, kinesthetic or tactile, often abbreviated as VAKT), time-of-day energy levels and the need for intake (food and drink) and mobility while learning.
		• Psychological: incorporates the information-processing elements of global versus analytic and impulsive versus reactive behaviours, hemispheric elements.
Stable personality type preferences	Myers-Briggs Type Indicator (MBTI) (Briggs Myers, 1962)	• Extraverts: try things out, focus on the world around, like working in teams, develop ideas through discussion.
		• Introverts: think things through, focus on the inner world of ideas, would rather work alone, ideas come from thinking alone.
		• Sensors: concrete, realistic, practical and detail-oriented, focus on facts and procedures, "see the trees instead of forest".
		• Intuitive: abstract, imaginative, concept-oriented, focus on meanings and possibilities, "see the forest instead of the trees".
		• Thinkers: sceptical, tend to make decisions based on logic and rules.
		• Feelers: appreciative, tend to make decisions based on personal and humanistic considerations.
		• Judgers: organised, set and follow agendas, make decisions quickly, dislike surprises and need advanced warnings, seek closure even with incomplete data.
		• Perceivers: disorganised, adapt to changing circumstances, gather more information before making a decision, enjoy surprises and spontaneous happenings, resist closure to obtain more data.

The cognitive structure family	Witkin's dimension - field-dependence versus field-independence	• Field-independent individuals are highly analytic, sample more cues inherent in the field and are able to extract the relevant cues necessary to complete a task. They tend to discern figures as discrete from their background, to focus on details and to be more serialistic in their learning (Witkin et al., 1977).
		• Field-dependent individuals process information globally and attend to the most salient cues regardless of their relevance. Field-dependent individuals typically see the global picture, ignore the details and approach a task more holistically. They tend to see patterns as a whole and have difficulty separating out specific aspects of a situation or pattern. Field-dependent individuals take a passive approach, are less discriminating and attend to the most salient cues regardless of their relevance. They also operate within an external frame of reference and prefer situations in which structure and analysis is provided for them (Witkin et al., 1977).
	Riding's model of cognitive styles	• Wholist-Analytic: this dimension describes how an individual tends to cognitively organise information either into (w) holes or parts. Wholists tend to form an overall perspective of a situation before delving down into the details, while analytics tend to see the situation as a collection of parts and focus on some of these at a time. (Most psychologists use the term holist instead of wholist.).
		• Verbaliser-Imager: this dimension describes how an individual represents information while thinking, either as words or mental pictures. For example, verbalisers tend to present information in words, while imagers tend to present information in pictorial form.
Learning approaches and strategies	Pask's model	• Serialists (partists): follow a step-by-step learning procedure, concentrating on narrow, simple hypotheses relating to one characteristic at a time.
		• Holists (wholists): tend to form more complex hypotheses relating to more than one characteristic at a time.
	Vermunt's framework for classifying learning styles and his Inventory of Learning Styles (ILS)	• Meaning-oriented learners prefer to get theory first and then go to examples. This dimension is very similar to the assimilating style of Kolb's model.
		• Application-directed learners want to know what the information is useful for; later on they develop the theory. This dimension is similar to the accommodating style of Kolb's model.

		• Reproduction-oriented learners need to know the goals; they try to reproduce the knowledge of experts. They want to get more questions and trial tests. This type is similar to the ¯eld-independent style of Witkin's model.
		• Undirected learners need to be guided. This type is similar to the field-dependent style of Witkin's model.
Flexibly stable learning preferences	Kolb's Learning Style Inventory (LSI)	• *Convergers*' dominant abilities are abstract conceptualisation and active experimentation. Therefore, their strengths lie in the practical applications of ideas. The name "Convergers" is based on Hudson's theory of thinking styles (Hudson, 1966), where convergent thinkers are people who are good in gathering information and facts and putting them together to find a single correct answer to a specific problem.
		• Divergers excel in the opposite poles of the two dimensions, namely concrete experimentation and reflective observation. They are good in viewing concrete situations in many different perspectives and in organising relationships to a meaningful shape. According to Hudson, a dominant strength of Divergers is to generate ideas and, therefore, Divergers tend to be more creative.
		• Assimilators excel in abstract conceptualisation and reflective observation. Their greatest strength lies in creating theoretical models. They are good in inductive reasoning and in assimilating disparate observations into an integrated explanation.
		• Accommodators have the opposite strengths to Assimilators. Their dominant abilities are concrete experience and active experimentation. Their strengths lie in doing things actively, carrying out plans and experiments, and becoming involved in new experiences. They are also characterised as risk-takers and as people who excel in situations that call for adaptation to specific immediate circumstances.
	Honey and Mumford's Learning Styles Questionnaire (LSQ)	• Activists involve themselves fully in new experiences, are enthusiastic about anything new, and learn best by doing something actively.
		• Theorists excel in adapting and integrating observations into theories. They need models, concepts, and facts in order to engage in the learning process.
		• Pragmatists are interested in real world applications of the learned material. They like to try out and experiment on ideas, theories, and techniques to see if they work in practice.

		• Reflectors are people who like to observe other people and their experiences from many different perspectives and reflect on them thoroughly before coming to a conclusion. For Reflectors, learning occurs mainly by observing and analysing the observed experiences.
	Felder-Silverman Learning Style Model	• Active learners learn best by working actively with the learning material, by applying the material, and by trying things out. Furthermore, they tend to be more interested in communicating with others and prefer to learn by working in groups where they can discuss about the learned material.
		• Reflective learners prefer to think about and reflect on the material. Regarding communication, they prefer to work alone or in a small group together with one good friend.
		• Sensing learners are considered as more realistic and sensible; they tend to be more practical than intuitive learners and like to relate the learned material to the real world.
		• Intuitive learners prefer to learn abstract learning material, such as theories and their underlying meanings, with general principles rather than concrete instances being a preferred source of information.
		• Visual learns from pictures, diagrams, flow charts, time lines, films, multimedia content and demonstrations
		• Verbal learns from written and spoken explanations.
		• Sequential learners learn in small incremental steps and therefore have a linear learning progress. They tend to follow logical stepwise paths in finding solutions.
		• Global learners use a holistic thinking process and learn in large leaps. They tend to absorb learning material almost randomly without seeing connections but after they have learned enough material they suddenly get the whole picture.

2.4 Felder-Silverman Learning Style Model and Correlations between learning styles

Learners are categorised by values on four dimensions. These dimensions are based on major dimensions in the field of learning styles and can be viewed independently from each other. In Felder-Silverman learning style model (FSLSM)

(Felder and Silverman, 1997) they show how learners prefer to process (active/reflective), perceive (sensing/intuitive), receive (verbal/visual) and understand (sequential/global) information.

There are many learning style theories used today and the learning style theories have been applied widely in educational environment, such as Myers-Briggs (Briggs Myers, 1962), Gregorc (1982a), Kolb (1984), Pask, (1976b), Honey and Mumford (1982) and Dunn and Dunn, (1974). Felder and Soloman developed the Index of Learning Styles (ILS) (Felder and Soloman, 1997); a 44-item questionnaire to help identify learning styles based on the FSLSM. As mentioned earlier, each learner has a personal preference for each dimension. These preferences are expressed with values between +11 to -11 per dimension, with steps +/-2. This range comes from the 11 questions that are posed for each dimension. Active learners learn best by working actively with the learning material, by applying the material and by trying things out. Furthermore, they tend to be more interested in communicating with others and prefer to learn by working in groups where they can discuss the learned material. In contrast, reflective learners prefer to think about and reflect on the material. Regarding communication, they prefer to work alone or in a small group together with one good friend. The active/reflective dimension is analogous to the respective dimension in Kolb's model (1984).

Learners with a sensory learning style like to learn facts and solid learning material, using their sensory experiences of particular instances as a primary source. They prefer to solve problems with standard approaches and also tend to be more patient with details. Furthermore, sensing learners are considered to be more realistic and sensible; they tend to be more practical than intuitive learners and like to relate the learned material to the real world. In contrast, intuitive learners prefer to learn abstract learning material, such as theories and their underlying meanings, and with general principles rather than solid instances being a preferred source of information. They like to discover possibilities and relationships and tend to be more innovative and creative than sensory learners. Therefore, they score better in open-ended tests than in tests with a single answer to a problem. The sensory/intuitive dimension is taken from the Myers-Briggs Type Indicator (Briggs Myers, 1962) and has also

similarities to the sensory/intuitive dimension in Kolb's model (Kolb, 1984). The third visual/verbal dimension deals with the preferred input mode.

The dimension differentiates learners who remember what they have seen best (e.g., pictures, diagrams, flow-charts and so on), from learners who get more out of textual representations, regardless of the fact whether they are written or spoken. The visual modality of the Dunn and Dunn model is split in two indicating preferences for pictures and text and is therefore correlated with the verbalised-imager dimension of Riding's model and the verbal-visual dimension of the Felder-Silverman mode. In the fourth dimension, Sequential learners learn in small incremental steps and therefore have a linear learning progress. They tend to follow logical stepwise paths in finding solutions. On the other hand, global learners use a holistic thinking process and learn in large leaps.

They tend to absorb learning material almost randomly without seeing connections, but after they have learned enough material they suddenly get the whole picture. Then, they are able to solve complex problems and put things together in novel ways; however, they have difficulties in explaining how they did it. Since the whole picture is important for global learners, they tend to be more interested in overviews and in a broad knowledge, whereas sequential learners are more interested in details. Learners are distinguished between a sequential and global way of understanding. This dimension is based on the learning style model by Pask (1976b), where sequential learners refer to serial learners and global learners refer to holistic learners (see figure 2.2).

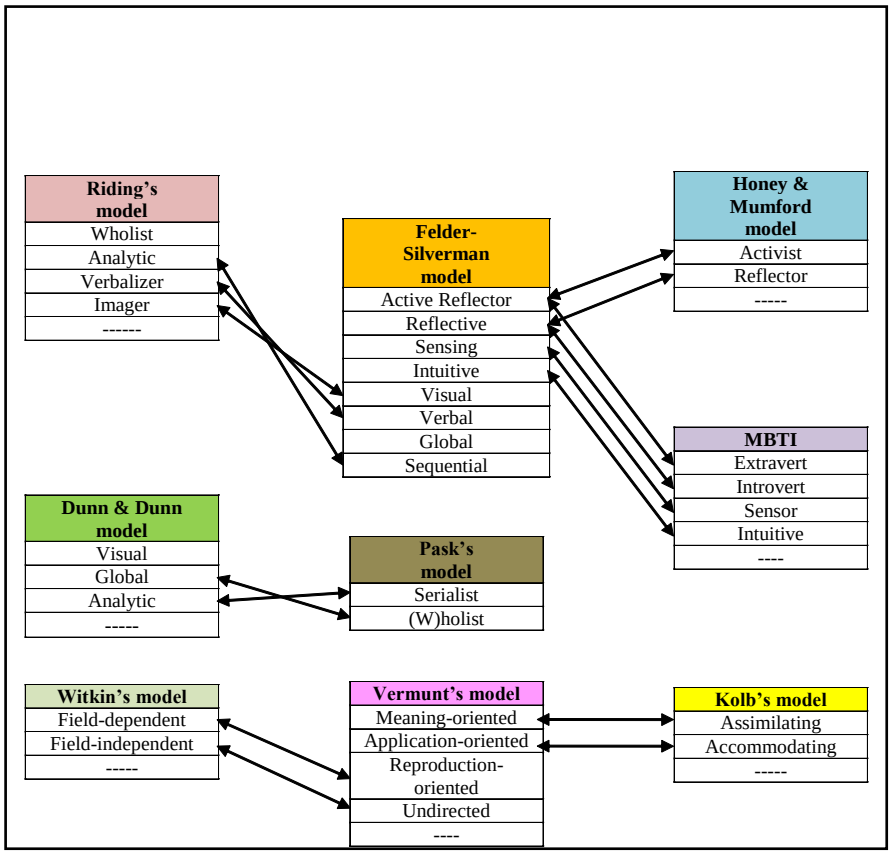

Figure 2.2: Correlations between Learning Styles

2.5 Adaptation in Educational Hypermedia Systems

Adaptivity in educational hypermedia systems consists of either a content level or a link level (Eklund & Brusilovsky, 1999). Content level adaptivity is the dynamic generation of content based on the learner model, whilst link level adaptivity assumes a static content and alters the appearance or prominence of the links connecting elements of this hyperspace (Eklund & Brusilovsky, 1999; Papanikolaou et al., 2002).

Adaptive educational Hypermedia Systems (AEHS) adopts the idea of offering learners personalised support and/or instruction. Several issues should be considered. First of all, it is essential to consider how learner behaviours and needs are reflected in the design of the system (Höök et al. 1996; Kay, 2001; Papanikolaou et al., 2003). AEHS reflect several learner behaviours in the design of the learner model, and apply this model to adapt various visible aspects of the system to individual learners (Brusilovsky, 1996; Kobsa, 2001; Papanikolaou et al., 2003). Another important issue is to design effectively the sharing of control between the

system and the learner (Hannafin and Sullivan, 1996; Shyu and Brown, 1995; Papanikolaou et. al., 2003), as many researchers acknowledge that learners appear to benefit from learner control opportunities (Jonassen et al. 1993; Shyu and Brown, 1995; Papanikolaou et. al., 2003). Furthermore, it is important to consider the educational potential of adaptation (McCalla, 1992; Papanikolaou et al., 2003) and to investigate the educational effectiveness of the use of adaptive educational environments.

In web-based Adaptive educational Hypermedia Systems (AEHS), many adaptive and intelligent technologies have been applied to introduce adaptation (Brusilovsky, 1999; Papanikolaou et al., 2002), such as Major Intelligent Tutoring technologies: curriculum sequencing, intelligent solution analysis and problem solving support. All these technologies have been well explored in the field of intelligent technologies system (ITS). The goal of curriculum sequencing technology is to provide the student with the most suitable individually planned sequence of topics to learn and learning tasks (examples, questions, problems, etc.) to work with. It helps the student to find an "optimal path" through the learning material. The context of web-based education (WBE), curriculum sequencing technology can become very important because it can help guide the student through the hyperspace of available information (Brusilovsky, 1999; Papanikolaou et al., 2003).

The interactive problem solving support provides the student with intelligent help on each step of problem solving. Intelligent help includes giving a hint to executing the next step for the student. Interactive problem solving support technology is not as popular in web-based systems as in standalone intelligent tutoring systems – mainly due to implementation problems.

Adaptive presentation and adaptive navigation support are two major technologies explored by adaptive hypertext and hypermedia systems. The adaptive presentation technology adapts the content presented in each hypermedia node (page) to student goals, knowledge, learning styles of the student and other information stored in the student model. In a system with adaptive presentation, the pages are usually not static but adaptively generated or assembled for each user (Brusilovsky, 1999; Papanikolaou et al., 2003). The goal of adaptive navigation support technology

is to help the student in hyperspace orientation and navigation by changing the appearance of visible links. Adaptive navigation support shares the same idea with curriculum sequencing – to help students find an "optimal path" through the learning material (Eklund & Zeilinger, 1996; Magoulas et al., 2003).

In this context, adaptation is defined as the concept of making adjustments in an educational environment in order to accommodate individual differences. Several levels of adaptation can be distinguished, depending on who takes the initiative to the adaptation: the learner or the system (Kay, 2001).

2.5.1 Review of similar research studies

Only a few systems that attempt to adapt to learning styles have been developed. However, it is still unclear which aspects of learning styles are worth modelling, and what can be done differently for users with different learning styles. We will show many different approaches that make use of learning styles in web-based education. Many educational systems that adapt to learning styles have been developed, including the system of Carver et al. (1999), the Arthur system (Gilbert & Han, 1999), the ACE – adaptive courseware environment (Sprecht & Oppermann, 1998), MASPLANG (Peña et al., 2002; Peña, 2004), LSAS (Bajraktarevic et al.,2003), INSPIRE (Papanikolaou et al.,2003), Iweaver (Wolf,2003), TANGOW (Paredes & Rodriguez 2004), EDUCE (Kelly,2005) and the system AHA! created by Cristea and de Bra (2006). Currently, many researchers agree on the importance of modelling and using learning styles. However, there is little agreement on aspects of learning style that are worth modelling, and what can be done differently for users with different styles (Brusilovsky, 2001). Moreover, the relationships between learning styles and possible interface settings are still unclear (Brusilovsky, 2001).

A number of adaptive educational systems have been developed based on learning styles. Examples of previous systems can be found below and a number of adaptive educational systems have been developed based on learning styles; a selection of these are collated in table 2.2 below.

Arthur: Similar to CS383 (discuss below), Arthur (Gilbert & Han, 1999; Gilbert, 2000; Gilbert & Han, 2002) was also a web-based environment. A novel aspect of Arthur was that the instructional materials were specifically designed for learning styles. Arthur used a metaphor of different virtual instructors, who each presented instructional materials in a different perceptual style. Arthur taught computer programming in C++ in phase one of the evaluation and then Planck's constant in phase two.

Evaluation: During phase one of the evaluation, Arthur was adaptable. If learners achieved less than 80% in a multiple choice test, they could freely choose their new learning style. In phase two, Arthur was adaptive: the system made the choice for the learners by using case-based reasoning, as described above. Two evaluations were reported (Gilbert & Han, 2000, 2002). In phase one, 89 participants used an adaptable version and in phase two, 21 participants used an adaptive version. Results from phase one can be used as supportive evidence for adaptive instruction in general. Gilbert and Han reported that it took students on average 1.72 attempts to pass a given concept by using 1.42 different instructional methods. This indicates that it was beneficial for students to repeat a concept in a different style.

MANIC: Multimedia Asynchronous Networked Individualized Courseware (MANIC) (Stern et al., 1997; Stern., Woolf, and Kurose, 1997) provided lecture-based material in terms of slides and audio material. The slides were constructed dynamically based on the students' level of understanding and their learning preferences. The system did not explicitly support a specific learning style model, but incorporated different aspects from different learning style models such as the Felder-Silverman learning style model. The concept for providing adaptivity (described in more detail in Stern and Woolf, 2000) was based on the stretchtext technique. Accordingly, basic learning material was presented to all learners. In order to detect the students' learning preferences, a Naïve Bayes Classifier was used. Information about the learners' preferences was gathered from their interaction with the system, when asking for hidden material to be shown or hiding presented material. This information was used by the Naïve Bayes Classifier to learn the

students' preferences. To improve the accuracy of this technique, population data were considered additionally.

Evaluation: A small online evaluation was described in Stern (2001). Data were collected in a repeated measures design under adaptive and non-adaptive conditions. However, many students quit the evaluation before they reached the midway-point. Therefore, only the data from 10 students could be used for the statistical analysis. As a result, only three limited conclusions were offered: (1) repeated measures designs have to be executed with care; (2) the calculated Bayes classifier differed between individuals, thus students seemed to learn differently; (3) the computer tutor was able to learn student's preferences, but it "must be able to continue to adapt and learn since the best policies for a given student may change" (p. 136).

CS383: CS383 (Carver et al., 1999) was the first adaptive educational hypermedia system that incorporated Felder-Silverman learning style model. The system provided adaptivity based on the sensing/intuitive, visual/verbal and sequential/global dimensions of FSLSM. As regards the active/reflective dimension, Carver et al. (1999) argued that the nature of hypermedia systems inherently supports both active and reflective learning.

The developed course consisted of a comprehensive collection of media objects, which include slide shows, hypertext, lesson objectives, a response system, a digital library and media clips. Based on the identified learning styles, the system offered students the option to order these objects in accordance with how well the multimedia objects fit their individual learning styles. The ranking of the multimedia objects was based on a coarse media granularity. Therefore, each media type received a ranking rather than ranking each single object.

Evaluation: No formal evaluation was reported. The researchers collected casual learner feedback and described it as uniformly positive.

ILASH: ILASH (Bajraktarevic et al., 2003) is an acronym constructed from the term "incorporating learning strategies in hypermedia". Two web-based courses were used as exemplary topics: "countries of the world" and "ozone layer depletion". ILASH

used the Felder and Silverman learning style model (Felder & Silverman, 1988) and the respective "index of learning styles questionnaire" (Felder & Soloman, 1997), but only the global/analytic elements were considered in the adaptation. ILASH also considered the knowledge state of each learner.

Evaluation: An empirical evaluation was carried out with 21 Year-10 students in a repeated measures design. First, the students were exposed to a matched version of the environment for the first course, then to a mismatched version for the second course. With regard to student achievement, statistically significant differences were found between pre- and post-test: students achieved higher scores in matched courses than in mismatched courses.

LSAS: Learning Style Adaptive System (LSAS) (Bajraktarevic et.al, 2003) incorporated the sequential/global dimension of FSLSM. To get information about the students' learning styles, the ILS questionnaire (Felder and Soloman, 1997) was used. Adaptivity was provided by two different user interface templates. For sequential learners, each page contained small chunks of information. On the other hand, global learners had more navigational freedom.

Evaluation: In order to evaluate the effectiveness of the system and the provided adaptivity, an experiment with 21 students was conducted. Students were asked to use the system to learn two subjects. While for the first subject, the system presented a course that matched the detected learning styles of the students, for the second subject the system presented a course that did not match their learning styles. According to the conducted pre-test and post-test for each subject, it could be seen that learners performed significantly better when the teaching style matched the learning style.

iWeaver: The architecture of iWeaver (Wolf, 2003) was based on the Dunn and Dunn learning style model (Dunn and Dunn, 1974; Dunn and Griggs, 2003). iWeaver incorporated several aspects of this learning style model and aimed at keeping a balance between the cognitive load of a learner, the accessible navigation option and the learning content. iWeaver was developed to teach the programming language

Java. The system was based on two concepts: media experiences which referred to the presentation modes and learning tools which were related to the psychological domain of the Dunn and Dunn learning style model.

When learners used the system for the first time, they had to fill out the "Building Excellence Inventory" (Rundle and Dunn, 2000) for assessing their learning styles according to the Dunn and Dunn learning style model. Based on the answers, the initial student model was built. Additionally, after each unit learners had to give feedback about the effectiveness, progress and satisfaction with the learning material. An extension of iWeaver was planned which aimed at updating the student model based on the behavior of the learners in the course, their feedback and the feedback of learners with a similar profile.

Evaluation: The participants were mainly young adults of mixed gender (28 female, 35 male) ranging from 18 to 52 years. The six evaluation sessions were conducted with different groups of students over a period of three days. The duration of individual sessions averaged about 90 minutes, held during three to four hour workshops. Some participants approached the researcher with informal and unprompted feedback. Despite exceeding the boundaries of the original data collection arrangement, these comments were anonymously recorded, because they were considered a valuable contribution to the cause of this study.

INSPIRE: Intelligent System for Personalized Instruction in a Remote Environment (INSPIRE) (Papanikolaou et al., 2003) allows learners to select their learning goal and accordingly generates lessons that correspond to specific learning outcomes, accommodating learners' knowledge level, progress and learning style. Learners have the possibility to intervene in the lesson generation process as well as make changes in their student model. Therefore, INSPIRE can act as an adaptive and adaptable system. INSPIRE combines two traditional instructional design theories, the Elaboration Theory (Reigeluth and Stein, 1983) and the Component Display Theory (Merrill, 1983), with the learning style model by Honey and Mumford (1992). For the four types of learning styles (Activist, Theorist, Pragmatist and Reflector), the learning material is adapted in terms of the method and the order of

the presentation. Although the behaviour and actions of the learners are tracked by the system, this information is not used for the detection of learning styles. Instead, a questionnaire developed by Honey and Mumford (1992) is applied and has to be filled out by the learners when they log in the first time. Alternatively, learners have the possibility to initialise or update their learning style in the student model.

Evaluation: In order to evaluate the adaptive and adaptable functionality of INSPIRE, a study with 23 students was performed. Results indicated that most students appreciated the functionality of the system and the support offered by it.

MASPLANG: MASPLANG (Peña, 2004; Peña et al., 2002) was a multi-agent system which was developed to enrich the intelligent tutoring system USD (Fabregat et al., 2000) with adaptivity regarding learning styles and the students' state of knowledge. In relation to learning styles, the Felder- Silverman learning style model was applied. USD was an adaptable platform which provides users the possibility to adapt courses to their needs by themselves.

Adaptivity based on learning styles was provided in terms of choosing the relevant media formats, instructional strategies and navigation tools. The adaptation features were based on the techniques used in CS383 (Carver et al., 1999) and the possibilities of the USD platform.

Evaluation: To check or prove that their adaptive learning approaches actually improve the learning experience or learning performance by surveying 14 teachers and 104 students (from six courses) by means of questionnaires and by monitoring the students actions in the system.

EDUCE: The EDUCE (Kelly & Tangney, 2004, 2005; Kelly, 2005) learning materials were computer based tutorials on the topics "static electricity" and "electricity in the home". Gardner's theory of multiple intelligences (1983/1993) was used to create different versions of the learning content. A multiple intelligence inventory named MIDAS was completed by students before they entered the learning environment. In EDUCE, multiple factors were measured for a continuing

adaptation, including time spent on a resource, order and repetition of resource visits and success in attempts to answer questions.

The student's multiple intelligence profile was matched and mismatched with different, custom-designed types of resources. EDUCE's scope was limited to four out of the eight intelligences (Gardner, 1999): logical/mathematical, verbal/linguistic, visual/spatial and musical/rhythmic. Four adaptation approaches were compared in two reported evaluations: free choice (no adaptation), one single adaptation (static profile), adaptive plus choice (static profile) and adaptive plus choice (dynamic profile).

Evaluation: Two evaluations were carried out in a repeated measures design; the first with 70 students (average age 14) and the second with 47 boys (average age 13). Independent variables were "choice" and "presentation strategy". Students were intentionally matched and mismatched with learning resources. Results of both studies indicated that low activity students learned better with learning resources they did not prefer, whereas the level of control had no conclusive effect on learning gain. However, a possible limitation of the EDUCE approach was that the environment automatically pre-selected a matched or mismatched resource first and only thereafter learners were given a choice of other resources. Additionally, EDUCE provided no clues for the learner how well suited the offered resources were.

AHA!: Similar to IDEAL, Adaptive Hypermedia for All (AHA!) (AHA! 2007; de Bra and Calvi, 1998; Stash et al., 2006) lets authors decide about the learning style model they want to implement in their course. Therefore, an authoring tool (de Bra et al, 2002) and a generic adaptation language for learning styles called LAG-XLS (Stash et al, 2005) were developed. The adaptation language allows three types of adaptive behaviour: selection of items to present, ordering information and creating different navigation paths (Stash et al., 2005). The authors can create their own instructional strategies, which define how the adaptation is performed based on the three types of adaptive behaviour, or reuse existing instructional strategies. Stash, Cristea and de Bra (2006) introduced predefined instructional strategies for an active

versus reflective learning style, Verbalizer versus Imagers, holist (global) versus analytic style and field-dependent versus field independent style.

Evaluation: Learners always have the possibility to change the information in the student model and therefore choose another instructional strategy (Stash et al, 2004, 2006). Stash, Cristea and de Bra (2006) conducted an evaluation of the usage as well as the authoring process in AHA!, with 34 students from computer science and business information systems. Two conclusions can be drawn from this evaluation. Firstly, significant differences were found when comparing the stated learning styles from the registration form with the results from ILS questionnaire. It can be concluded that students might possess only little meta-knowledge on their learning style preferences and therefore the student model might be filled with incorrect data. Secondly, when students were asked to act as authors and create new instructional strategies and meta-strategies, they stated that they had difficulties. This result underlines that for the creation of new strategies many psychological and/or pedagogical knowledge as well as specific knowledge about learning styles are required.

Table 2.2: Adaptive educational hypermedia systems based on learning styles

System	Learning style model	Student modeling approach	Methods for providing adaptivity	Empirical studies
CS83(Carver et al., 1999)	Sensing/ intuitive, Visual/verbal and sequential/global dimension of FSLSM	Inventory of learning styles questionnaire	Ordering of multimedia objects	Informal assessment over two years using end of course survey, Different students rated different media components as best and worse
Arthur (Gilbert and Han, 1999)	Determined by instructor	Learning style preference	Various styles of instruction such as visual-interactive, auditory-text, auditory-lecture and text style	Majority of learners(81 % out of a group of 21 students) complete the course while performing at a mastering level on quizzes found at the end of each lesson
iMANIC (Stern & Wolf 2000)	Preferences for: media, type of instruction, level of content abstractness, ordering of content	Adapts to learner's selection of different types of resources	Presentation of content using stretch text which allows certain part of page to be opened or closed. Also, sequencing of content objects for a concept	Evaluated accuracy of classification. Possible to learn parameters for each student within few slides that achieved optimal classification
ILASH (Bajraktarevic et al., 2003)	Sequential/global dimension of FSLSM	Index of learning styles questionnaire	The difference in presentation of the two types of formats is apparent. For the students with a global learning style preference, pages comprised elements such as a table of contents, summary, diagrams, overview of information, etc. For sequential students, the pages contained small chunks of information, text-only pages with 'forward' and 'back' buttons	An empirical evaluation was carried out with 21 Year-10 students in a repeated measures design. First, the students were exposed to a matched version of the environment for the first course, then to a mismatched version for the second course

LSAS(Bajraktarevic, Hall and Fullick, 2003)	Sequential/global dimension of FSLSM	Index of learning styles questionnaire	Hiding/presenting additional links and course elements	In order to evaluate the effectiveness of the system and the provided adaptivity, an experiment with 21 students was conducted. Students were asked to use the system to learn two subjects.
INSPIRE(Papanikolaou et al., 2003)	Honey and Mumford learning style model	Questionnaire by Honey and Mumford or initialising/updating the student model manually	Method and order of the content presentation	Formative study with 23 subjects. Indicates that studying behaviours of specific learners were representative of learning style categories
I weaver(Wolf,2003)	Presentation preferences and psychological preferences with respect to the Dunn and Dunn learning style model	Building Excellence Inventory; automatic approach is planned	Link ordering and link hiding for selecting different presentation modes and learning tools	The study was carried out with 63 students. ADoM is a two-year RMIT TAFE course with a focus on a variety of digital design approaches including imaging, video, interactive authoring, animation, games development and web page authoring.
MASPLANG (Peña, Marzo, and de la Rosa, 2002; Peña, 2004)	FSLSM	Index of learning styles questionnaire for initialising and a case-based reasoning process for fine-tuning	Adaptation in terms of choosing the relevant media formats, instructional strategies and navigation	Surveying 14 teachers and 104 students (from six courses) by means of questionnaires and monitoring the students actions in the system
EDUCE (Kelly,2005)	Gardner's theory of multiple intelligences	Multiple intelligence inventory named MIDAS was completed by students before they entered the learning environment.	Four adaptation approaches were compared in two reported evaluations: free choice (no adaptation), one single adaptation (static profile), adaptive plus choice (static profile), and adaptive plus choice (dynamic profile).	Two studies were conducted with EDUCE, in order to explore how the learning environment should change for users with different characteristics. In Study 1, 70 boys and girls participated. In Study 2, 47 boys from one mixed ability school participated

AHA!(Cristea, and de Bra, 2006)	Determined by the teacher	Manually initialised and updated by determined instructional meta-strategies	Adaptation in terms of selection of items to present, ordering information and creating different navigation paths	With 34 students from computer science and business information systems

2.6 Description of gaps

This research addresses a major gap in knowledge, that of the suitability and applicability of psychometric instruments and adaptive learning systems to a non-English speaking environment. Existing instruments have typically been written in English for a Western culture. For instance, there may be linguistic differences in a literal translation of questions or items, resulting in subtle or even significant different meanings in the translated instruments, thus threatening the validity and reliability of measurement. In addition, this research develops an adaptive learning system for an Arabic speaking community.

This is the first example of an adaptive learning system being applied to an Arabic speaking environment. Currently, there is debate on the effectiveness of adaptive systems: it is not clear whether they produce better learning environments for everyone. This present study hopes to contribute to research on the suitability of adaptive learning systems for the Arabic speaking community. However, it is still unclear which aspects of learning styles are worth modelling, and what can be done for users with different learning styles. This is an issue that should be addressed in any research into adaptive learning systems based on learning styles.

Three general design issues were identified in existing environments. Firstly, the applied learning style models had gaps. Several were based on self-assessment; others did not include the perceptual dimension such as visual, which is widely recognised in the literature. Secondly, adaptive components were rarely custom-designed. Instead, existing media were often re-used from earlier courses. Thirdly,

existing environments often restricted learner control. This project attempted to overcome the identified gaps by (1) using a well-researched and more comprehensive learning style model, (2) using custom-designed instructional strategies, media format, navigation tools and (3) allowing learners to choose and switch between styles at any time. However, it is still unclear which aspects of learning styles are worth modelling, and what can be done differently for users with different learning styles. This is an issue that should be addressed in any research into adaptive learning systems based on learning styles

2.7 Summary

This chapter provided a review of the learning styles theory. It discussed the most popular and influential LS models: Dunn and Dunn model, Myers-Briggs Type Indicator; Kolb's Earning Style Inventory, Honey and Mumford's Learning Style Questionnaire, Felder and Silverman's Index of Learning Styles, Pask's model and Vermunt's model. A number of conclusions can be drawn from the literature reviewed. Technology enhanced learning environments, and in particular adaptive educational systems offer the potential to support individual differences in learning. This research has examined the impact of learning styles on learning, but it has been difficult to prove conclusively how learning styles can be supported and improve learning outcomes.

In particular, the theory of Felder-Silverman learning style offers the potential to provide a framework for a broad range of individualised pedagogical strategies, while building on research that demonstrates how adaptive of learning styles can be a predictor of learning performance, Also, this chapter summarised the main conclusions of the literature review and argued that this research addresses the challenges in building adaptive educational systems that support individual trait differences in a novel manner. This chapter has touched on the various reviews of similar research studies and description of gaps.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the philosophical approach and methods that underpin the research. Also, this chapter examines overall research methodology and design, specifically focusing on research design in the literature review, choosing an appropriate learning style measurement, instrument validity and reliability, creating the initial Teacher Assisting and Subject Adaptive Material System (TASAM) and developing and testing said system. There is also an initial and final evaluation and assessment of the adaptive learning system by students and tutors.

3.2 Research Approach

Research approaches rely on standardised and suitable research methods which give research credibility (Glaser et al., 1968), since the nature of the variables and data involved in this research are important to determine an appropriate research method, as well as the statistical test to use in a given inquiry. The use of the positivist and interpretive philosophical approaches helped the researcher to collect and analyse the voluminous data involved in this research. Research methods are either based on a quantitative or/and qualitative research techniques (Hammersley, 1996) and therefore the researcher made use of these philosophical approaches which have been identified to be suitable, practised and reliable.

Research can have fundamentals that are based upon a non-empirical approach, an empirical approach, or a combination of the two. For the empirical approach, there are three main dimensions which can be evaluated for use: qualitative/quantitative, deductive/inductive and subjective/objective.

3.2.1 Positivist Research

Positive research implicitly assumes that reality can be objectively defined and described, using measurable properties that can be assessed by independent observers. Positivist research attempts to articulate and test theories, in order to promote the predictive understanding of phenomena Creswell, (1998). The tools used by positivist researchers include experiments, surveys, questionnaires, case studies and simulation (Baskerville and Wood-Harper, 1996). Research is positivist if it includes formal propositions, quantifiable measures of variables, the testing of hypotheses and inferences about a phenomenon from a population sample (Creswell, 1998).

3.2.2 Interpretive Research

Interpretative research assumes that access to reality is a function of social constructions, which need to be analysed, decoded and represented (Creswell, 1998). The goal of an interpretive study is to understand particular phenomena by assessing the meanings that individuals assign to those phenomena (such as interviews, questionnaires and session discussions, which were used in this research) (Baskerville and Wood-Harper, 1996). Interpretive research also attempts to determine the context of information and how it influences knowledge (Creswell, 1998).

3.2.3 Non-empirical research

One of the first considerations is the pre-existing body of knowledge in a particular field. Some research depends entirely upon this research method (more generally known as searching and reviewing the literature), on a certain subject, where the subject may be one, for example, of an historical nature, which does not lend itself to any other form of investigation.

3.2.4 Empirical research

According to Hussey and Hussey (1997:10), “four different types of research purpose exist: exploratory, descriptive, analytical or predictive.” No matter what the

purpose of the research, empirical evidence is required. They define empirical evidence as, "data based on observation or experience." This understanding of the importance of gathering empirical data by observation or experience is also identified by Easterby- Smith et al. (1991).

3.2.4.1 Qualitative/Quantitative approach

Another choice was whether to adopt a quantitative or qualitative approach, or some mix of the two. Many authors (Cavaye, 1996; Darke et al., 1998; Hussey and Hussey, 1997; Leedy and Ormrod, 2001; Miles and Huberman, 1994; Myers, 1997) have commented on the choice between qualitative and quantitative methods in fieldwork (empirical) research. Myers (1997) distinguished between qualitative and quantitative research methods.

Quantitative research methods were originally developed in the natural sciences to study natural phenomena. Examples of quantitative methods, now well accepted in the social sciences, include survey methods, laboratory experiments, formal methods (e.g. econometrics) and numerical methods such as mathematical modelling.

Qualitative research methods were developed in the social sciences to facilitate researchers in studying social and cultural phenomena. Examples of qualitative methods are action research, case study research and ethnography. Qualitative data sources include observation and participant observation (fieldwork), interviews and questionnaires, documents and texts and the researcher's impressions and reactions (Myers, 1997: online).

3.2.4.2 Deductive or Inductive approach

Hussey and Hussey (1997) defined deductive research as a study in which a conceptual and theoretical structure is developed and then tested by empirical observation; thus particular instances are deducted from general influences. Deductive research is a study in which theory is tested by empirical observation. The deductive method is referred to as moving from the general to the particular.

Inductive research is a study in which theory is "developed from the observation of empirical reality; thus general inferences are induced from particular instances, which is the reverse of the deductive method since it involves moving from individual observation to statements of general patterns or laws" (Hussey and Hussey, 1997:13). Inductive research is a study in which the theory is developed by general inference of induction from particular instance. It is referred to as moving from the particular to the general.

Cavaye (1996) does not prohibit the combined use of both inductive and deductive approaches. The possibility of using both inductive and deductive approaches in the same case study has also been discussed by Perry (2001). He describes a continuum from pure induction (theory-building) to pure deduction (theory-testing). He advocates taking a middle-ground of a balance between the two, striking the position of what he calls "theory confirming/disconfirming" approach.

3.2.4.3 Subjective / objective

Another significant choice which exists in the research paradigm to be adopted is the extent to which the researcher is subjective approach using more intuitive or qualitative approaches, and depending on what data is available and the distance into the future for which a forecast is desired. Objective approach for nearer term forecasting horizons and for events where there is plenty of quantitative data available. More distant time periods, or events with a lack of historical quantitative data will often call for more subjective approaches. http://analysights.wordpress.com

3.3 Justification of this research approach

This research uses the positivist philosophical approach because it surveys, for example questions of FS-LSI questionnaire to find out the learning style of student, Questionnaire of evaluation Teacher, Questionnaire of evaluation student and results of experiments to develop the adaptive system for adapting based on learning styles. It also uses Interpretative philosophical approach because it surveys for example, Questionnaire of evaluation Teacher , Questionnaire of evaluation

student to see the feedback of teacher and students , Discussion with specialists (Semantic equivalence): This has the aim of exploring whether the various domains covered by the original instrument in defining the concepts of interest would be relevant and pertinent to the new context for which it is being adapted: effectively did the translated questions make sense as translated psychometric concepts and session discussions with a group of 9 bilingual participants (two being professional bilingual translators) to review the questions. Questions were read to the group in both Arabic and English and discussions followed each question on meaning and interpretation in both languages. Alternative phrases and translations were reviewed resulting in a refined questionnaire being produced.

This research has been designed to take into account both the non-empirical and empirical research approaches. The non-empirical approach was used to review of previous works covering adaptive learning systems, and analysis of these secondary data to gain detailed knowledge of the subject area, to identify gaps in adaptive learning systems, which go a long way to facilitate the selection and design of appropriate tools and methods for creating adaptive system

This research uses quantitative approach examples of quantitative methods now well accepted in the social sciences include survey methods and labs experiments. Also this research uses qualitative research methods to see informal comments and feedback directly after using the system along with formal feedback in the survey. This research has applied the Felder-Silverman Learning Style Theory (LST) (Felder and Silverman to create and develop an Adaptive system for adapting based on learning styles. This process is from the general to the specific. So, the deductive approach is logic of the research (see Figure 3.2).

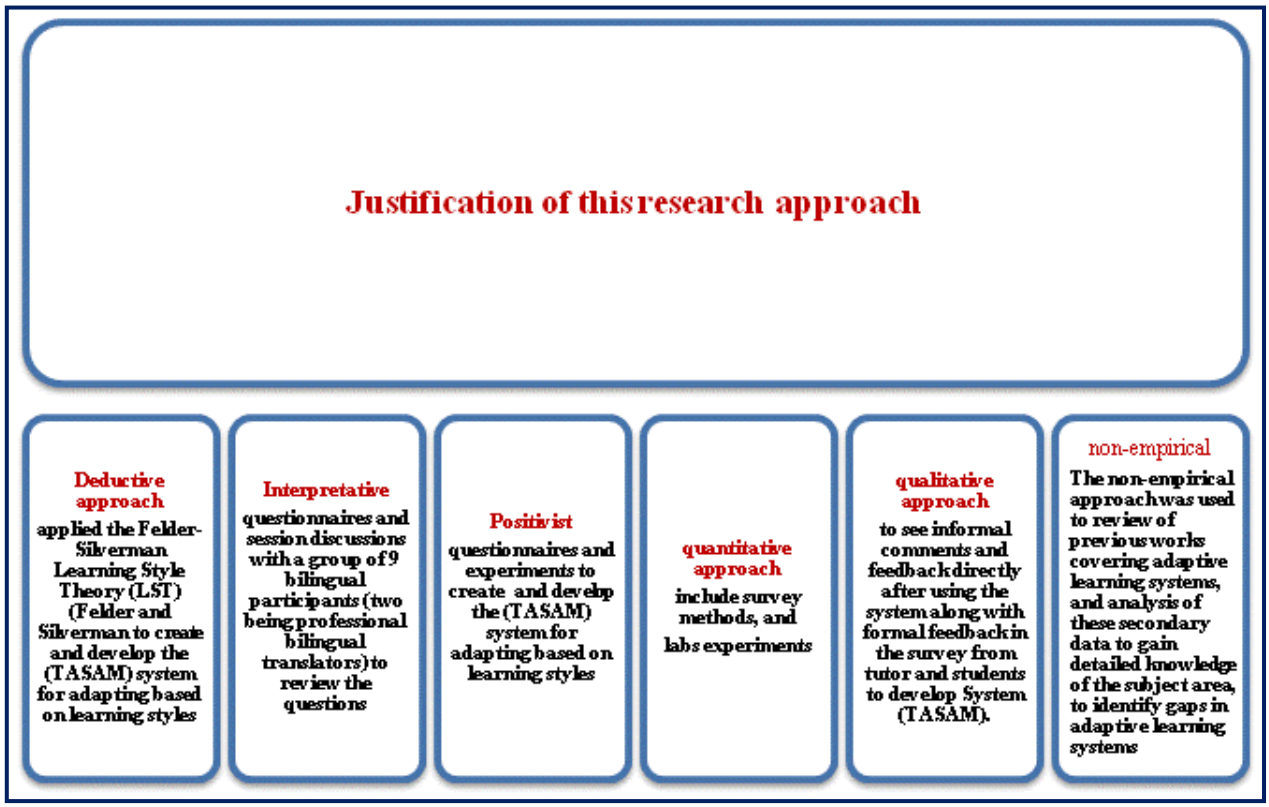

Figure 3.2: Philosophical Approach of this research

3.4 Research Design

A research design is a framework or blueprint for conducting a research or study, and used as a guide in collecting and analysing data .This section examines the process of the main research design as covered in figure 3.3

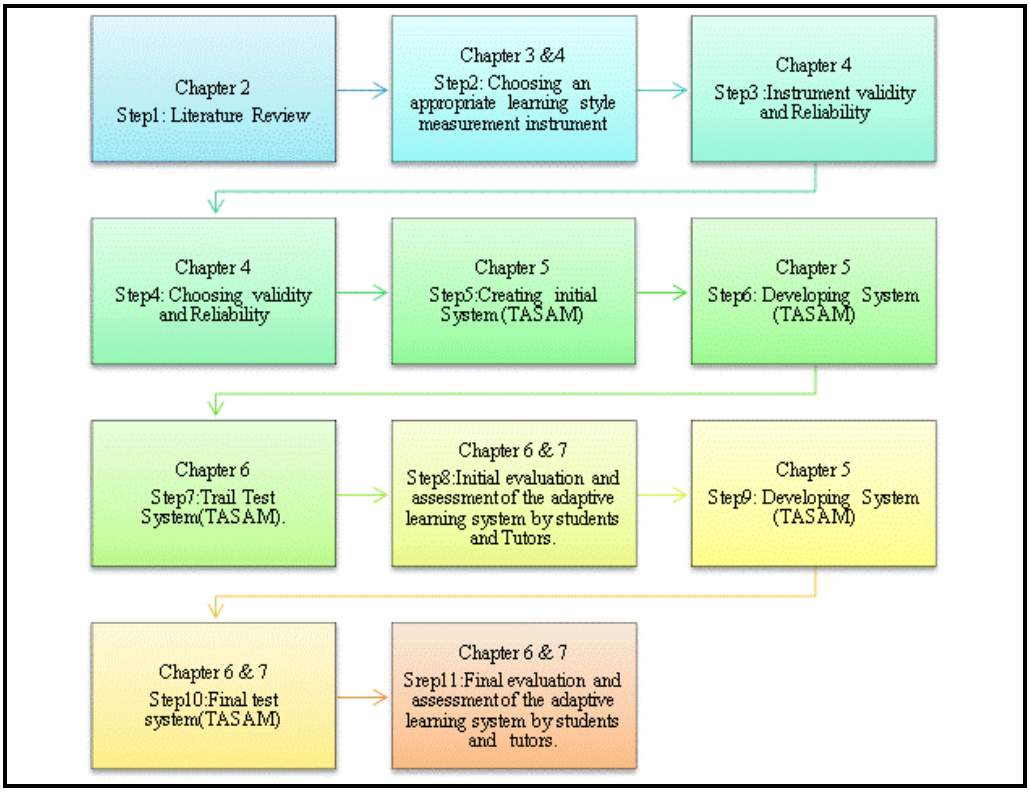

Figure 3.3: The process of the main research design

3.4.1. Literature Review

The review examines previous works covering adaptive learning systems as indicated in Figure 3.4 and analyses the secondary data to gain detailed knowledge of the subject area, in order to identify gaps in adaptive learning systems, which goes a long way to facilitating the selection and design of appropriate tools and methods for creating adaptive system. Finally, insight and broader understanding was gained on creating The Teacher Assisting and Subject Adaptive Material adaptive System: An Arabic Adaptive learning Environment (see Chapter Two).

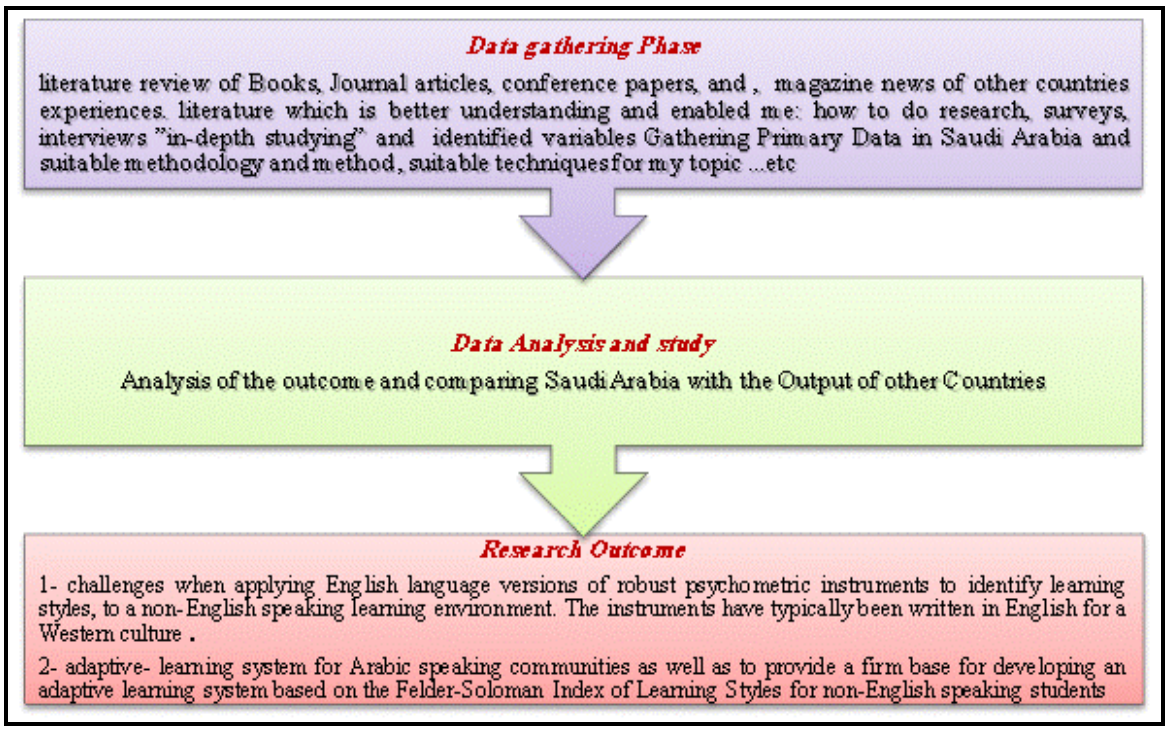

Figure 3.4: Iterative process continually reviews the literature

3. 4.2 Choosing an appropriate learning style measurement instrument

The process of choosing an appropriate learning style measurement instrument is described in the following:

- Achieved by reviewing the literature and previous works covering learning styles theories.
- Searching for examples of learning styles theories and reading each example of learning style theories, and the descriptions of each scale or dimension of learning style theories.
- Compared each learning style theory to the other.
- Read and focused on how each learning style theory developed. Notably, Felder's theory of learning styles (1993) consisted of 44 questions, which were easy for students to answer.
- Met with psychologists to ask them about Felder-Silverman Learning Style Theory (LST) (Felder and Silverman). They read the material and stated that it is new and had not been applied before in Saudi Arabia. They also noted that it

contains 44 questions that are easy for students to answer. There were other theories that were discussed after that which contained 100 questions. One hundred questions are too many; students will not be interested to answer this number of questions.

- Contacted author of the theory as requested by the psychology experts to ask permission for translation to Arabic.
- Contacted author of the Felder-Silverman Learning Style Theory (LST), who told me that nobody had done validity and reliability in an Arabic version.
- The author of the Felder-Silverman Learning Style Theory (LST) asked me to get permission from my supervisor, who was in charge of the thesis, for validity and reliability in an Arabic version of Felder-Silverman Learning Style Theory (LST).
- Contacted the supervisor and he was very pleased and gave me permission to do validity and reliability in an Arabic version. One reason why I chose this theory is that nobody had ever conducted validity and reliability in an Arabic version (for more details see Chapter Four).

3. 4.3 Instrument validity and reliability

Reliability and validity therefore provide positive information about the suitability of selecting various scales or measurements for use within research projects. Other considerations include the preparation of questionnaires, such as response types and the wording of questions so as to avoid jargon, loaded or complex words and questions, and any cultural or emotional bias. Pallant suggests that, where possible, questionnaires should also include provisos for “don’t know” or “not applicable” (Pallant, 2005). Some researchers in the Information Systems (IS) field have pointed out that the scientific basis of IS research cannot be proved without the solid validation of the research (Straub et al., 2004; Boudreau et al., 2003). The instrument validity and reliability is covered in Chapter Four.

3.4.4 Choosing Instrument validity and reliability

The process of choosing the validity and reliability instrument is outlined below (Aljojo and Adams, 2009; Aljojo and Adams, 2010). For more detail see Chapters Four and Seven.

- Experts in psychology and statistics will be consulted and asked about the validity of the questionnaires. They will also explain the differences between instrument validity and reliability, and how to make reliable and valid questionnaires.
- Richard Felder, one of the authors of the Felder-Silverman Learning Style Theory (LST), will be contacted and provided with all the papers related to validity and reliability of Felder-Silverman Learning Style Theory (LST).
- The author will give his site address, which contains all papers related to validity and reliability of Felder-Silverman Learning Style Theory (LST). Based on that, the right way of making validity and reliability will be chosen (for more details see Chapter Five).

3.4.5 Creating the initial system (TASAM)

The Process of creating the initial system (TASAM) is described in the following (for more details see Chapter Four)

- Reviewing literature and previous work covering the adaptive system.
- Searching for examples of the adaptive system and reading each example of adaptive system especially Adaptive System using Felder-Silverman Learning Style Theory (LST).
- Comparison of the Adaptive Systems.
- Creating the initial system (TASAM) using a similar approach that takes advantage of the versatility offered by teaching the tools of MASPLANG and

Carver In (Car, 1999) environments. The teaching content and navigation tools to match learning styles have been adapted. For more details see Chapter 5. This is also mainly covered in Aljojo and Adams (2009).

3.4.6 Developing System (TASAM)

The review of the literature and previous works covering adaptive learning systems using taxonomy has been constructed based on an evaluation of Soloman–Felder learning style theory and usage of e-media. It also builds on previous work, such as Franzoni et al. (2008), which used an expert panel that adopted the Delphi method held during the III Congreso de Estilos de Aprendizaje at Cáceres (Spain) in July 2008. For more details see Chapter 5. This is also mainly covered in Aljojo and Adams (2010).

3.4.7 Trial Test of System (TASAM)

The overall process for the Initial Test of the system (TASAM) consisted of:

- Reviewing the literature and previous works covering testing of the adaptive learning systems.
- Reading the method of experimentation for each adaptive system and what tools will be used in the experimentation.
- Meeting with psychology experts to ask them how to test my system.
- Selecting the appropriate method for testing my system.
- Meeting with psychology teachers to arrange with them to test my adaptive system on student second level of statistics.
- Meeting with students of first and second level of statistics.
- Giving the students information and guidance on how to use the TASAM system, and asking them to fill out the ILS questionnaires online. Each student is aware of his or her learning style.
- Giving students a pre-test relating to chapters before they started using the adaptive learning system.
- At the end of the experimentation, students were given a post-test relating to chapters after they had used the adaptive learning system. The pre-test and

post-test results were compared to examine the impact of the adaptive on students' performance. Chapters Six and Seven discuss the trial test of the Teacher Assisting and Subject Adaptive Material (TASAM) system using three different groups, and mainly covered in Aljojo and Adams (2010).

3.4.8 Initial evaluation and assessment of the adaptive learning system by students and Tutors.

Evaluation is essential for validating the usefulness of environment. The evaluation should consider the quality and effectiveness of the teaching and learning process. This is fundamental in design of distance courses and learner support (Gal 2001; Peña, 2004), It is mainly covered in Aljojo and Adams (2010), and Chapter Seven. The following outlines the process of initial evaluation and assessment of the adaptive learning system by students and tutors described in this section:

- Reviewing literature and previous works covering evaluation of adaptive learning systems.
- Writing the questionnaire to evaluate teachers and students.
- Giving the questionnaire of evaluation to psychology experts to read and give comments.
- Rewriting the questionnaire for evaluating teachers and students after comments from the psychology experts.
- Distributing the questionnaire to students and teachers.
- Analysing the responses of the questionnaire.
- Analysing the data derived from the teachers and students evaluation questionnaires, in order to see informal comments and feedback directly after using the system along with formal feedback in the survey from tutors and students to develop the system (TASAM), is mainly covered in Aljojo and Adams (2010), and Chapters Four and Seven.

3.4.9 Final test system (TASAM)

The overall process for the final Test System (TASAM) consisted of:

- Meeting with psychology teachers to arrange with them to test my adaptive system on students of first and second level of statistics.
- Meeting with the students and giving them guidance on how to use the TASAM system.
- Asking them to fill out the ILS questionnaires online. Each student is aware of their learning style.
- Giving students a pre-test relating to the chapters given before the adaptive learning system. At the end of the experimentation, giving students a post-test relating to chapters, which were given after they used the adaptive learning system. The pre-test and post-test results are compared to determine the impact of the adaptive on students' performance. The final test system (TASAM) is discussed in Chapter Seven.

3.4.10 Final evaluation and assessment of the adaptive learning system by students and tutors

- Using the same questionnaire for evaluating teachers and students. This was utilised in the initial evaluation and assessment of the adaptive learning system.
- Distributing the questionnaire.
- Analysing the results of the questionnaire. For more details see Chapter Seven.

3.5 Summary

This chapter discussed how research can have fundamentals that are based upon a non-empirical approach or an empirical approach. For the empirical approach, there are three main dimensions which can be evaluated for use: qualitative/quantitative, deductive/inductive and subjective/objective. Furthermore, this chapter examined the process of main research design.

CHAPTER 4

A STUDY OF THE RELIABILITY AND VALIDATING OF THE FELDER-SOLOMAN INDEX OF LEARNING STYLES IN ARABIC

4.1 Introduction

This chapter presents the Felder-Silverman Learning Style, its definition, and the reasons for its choice. Furthermore, this chapter examines the method of selection of a random sample and then extends the current debate and knowledge based around translation of research instruments by presenting a procedure used for translation and cultural adaptation to produce an Arabic version of the Felder-Silverman learning style instrument (FSLSI). The procedure provides guidance and operational framework to help researchers apply a cross cultural adaptation of instruments. This Arabic version of the FS-LSI was applied to a selection of female students from two faculties in King Abdul-Aziz University in Saudi Arabia – Arts and Humanities and Economics and Administration. The study covered 1024 students in total. The procedure presented provides extensions of validating instruments, using such items as content validity and factor analysis, within the translated language. It is particularly aimed at Arabic communities, though the generic procedure can be applied to other cultures and languages.

Cross cultural adoption of psychometric instruments has many challenges, as Rode (2005) identifies when discussing instrument validity: “Before using statistical methods on any data, we should make sure that the data really represent the concepts they are supposed to measure and that they do it reliably. Assuring validity and reliability isn’t a simple task. Developing valid and reliable measurement instruments requires much work, time and knowledge.” Furthermore, “It is much easier to adopt instruments already developed by other researchers” (Rode, 2005, p. 15). In a similar light, Zvezki (2005) identifies that there are a number of measurement instruments available, which promise the desired validity and reliability, as well as other useful characteristics. However, adopting instruments developed by other researchers frequently means applying the instrument to the local context, which involves greater

challenges if the instrument has to be translated into other languages. In order to preserve the properties of the instrument, such translations mostly follow the Ask-the-Same-Question model, often involving verbatim translation of the questions (Reichenheim and Moraes 2010; Harkens, Van der Vijver, and Johnson, 2003; Zvezki, 2005). However, these types of translation of instruments involve a number of problems. As Reichenheim and Moraes (2007) identify, connotations can be lost in such translation. For instance, some words have special historic connotations in some countries and not in others. They argue that most of these problems could and should be solved when the instruments are developed. However, the initial instrument development may not involve consideration of wider applicability to all other or even any other cultures and languages. Reichenheim and Moraes (2007) suggest that a useful strategy is 'cultural decentering of the instrument', which aims to remove the words and concepts that are difficult to translate or are specific to a particular culture (Van der Vijver and Leung, 1997, Harkens, van der Vijver, and Johnson, 2003; van der Vijver, 2003; Zvezki, 2005).

A common approach to the translation problems is the back-translation procedure where an instrument is first translated into the target language and then translated back to the source language by an independent translator (e.g. van der Vijver and Leung, 1997; Zvezki,2005). Comparing the original and the back-translated versions of the instrument can reveal likely translation problems. Reichenheim and Moraes (2007), in examining the set up of such instruments, further suggest the need for detailed literature review, which includes examination and close scrutiny of the level of previous use of such instruments and the research programmes. This type of evidence is needed for the researcher to decide if there are satisfactory instruments for exploring the object(s) to be studied. Moreover, if the instruments have been developed and used in other cultural and language contexts then it is also important to investigate whether they have already undergone robust formal cross-cultural adaptation (CCA) processes.

4.2 Felder-Silverman Learning Style Theory

A learning style is defined as the unique collection of individual skills and preferences that affect how a student perceives, gathers and process learning materials (Johnson and Orwig,1998; Kinshuk and Lin,2003). Each individual has his/her unique way of learning. Learning style greatly affects the learning process, and therefore the outcome (Carver, et al., 1999; Vincent and Ross, 2001). In recent years, the learning style area has been greatly developed. Numerous learning style theories have been applied in educational practices, e.g. Kolb's learning style theory (Kolb and Fry, 1975; Kolb, 1984), Gardner's Multiple Intelligences Theory (Gardner,1993), Felder-Silverman Learning Style Theory (Felder and Silverman, 1988; Felder, 1993; Kinshuk and Lin,2003). From the existing learning style theories, the Felder-Silverman Learning Style Theory is chosen to be implemented in this research. The reasons are:

- Its Index of Learning Style (ILS) questionnaire (Felder and Soloman, 2003) provides a quick and easy way to diagnose the dominant learning style of each student.
- The results of ILS can be linked easily to adaptive environments (Paredes And Rodriguez, 2002).
- It is suitable for hypermedia courseware (Carver, et al., 1999; Kinshuk and Lin, 2003).
- Index of Learning Style (ILS) questionnaire contains 44 questions that are easy for students to answer. There were other theories that were discussed after that which contained 100 questions. One hundred questions are too many; students will not be interested to answer this number of questions.
- It describes learning styles in great detail, distinguishing between preferences on four dimensions. By using these dimensions, FSLSM combines major learning style models such as the ones by Kolb (1984), Pask (1976b) and Myers-Briggs (Briggs Myers, 1962).

This theory assesses the student's learning style using b sliding scale of five dimensions: sensing-intuitive, visual-verbal, inductive-deductive, active-reflective and sequential-global (Felder and Silverman, 1988; Felder, 1993).

In 1988, the inductive-deductive dimension was deleted from the previous theory by Felder and Silverman, because of difficulties in teaching. Thus, as shown in table 4.1, this theory defines a student's learning styles based on a sliding scale of four dimensions: sensing-intuitive, visual-verbal, active-reflective and sequential-global. From these dimension descriptions of learning styles, a questionnaire – Index of Learning Styles is developed by Felder and Soloman (Felder and Soloman, 2003).

Table 4.1: Felder's learning dimensions (Felder and Silverman, 1997; Carver, et al., 1999)

Definition	**Dimension**		**Definition**
Do it	Active	Reflective	Think about it
Learn facts	Sensing	Intuitive	Learning concepts
Require Pictures	Visual	Verbal	Require reading or lecture
Step by step	Sequential	Global	Big picture

The aim of the ILS questionnaire is to help learners to identify their dominant learning styles. The questionnaire has 44 questions; each comes with two possible answers – A or B. All questions are classified into four pairs in the Felder and Silverman Learning Style theory. The results of the questionnaire are explained as follows:

- If your score on a scale is 1-3, you have a mild preference for one or the other dimension but you are essentially well balanced. (For example, a 3a in the active-reflective category indicates a mild preference for active learning).
- If your score on a scale is 5-7, you have a moderate preference for one dimension of the scale and will learn more easily in a teaching environment which favors this dimension.

- If your score on a scale is 9-11, you have a strong preference for one dimension of the scale. You may have real difficulty learning in an environment which does not support that preference.

4.3 Instrument Validity and Reliability

Instrument validity is an important part of any research and refers to how appropriate, meaningful and useful the specific inferences made from the test scores are. Traditionally, the validity of an instrument's support has been determined by examining construct, content and criterion-related concepts.

Construct validity is how well an instrument measures a certain construct (Cronbach & Meehl, 1955; DeVon et al., 2007). An instrument might be "constructing valid" but not capable of measuring the intended construct.

Face validity means that the instrument looks, on the face of it, as if it measures the construct of interest. It is the easiest way to claim support for construct validity and, as a result, is frequently reported in the literature. Face validity is, however, subjective so it is the weakest form of validity (Trochim, 2001; DeVon et al., 2007). This is not a form of validity in the sense of indicating that the tool performs correctly and is actually measuring the construct. However, it does tell us how potential users might interpret and respond to the items. Investigators look for experts (Netemeyer et al., 2003; Devon et al., 2007) or ordinary people (Schultz & Whitney, 2005; Devon et al., 2007) to review the instrument for grammar, syntax, organisation, appropriateness and confirmation that it appears to flow logically.

Content validity is indicated if the items in the tool sample the complete range of the attribute under study. To develop a pool of scale items, a researcher first defines the construct of interest and its dimensions by searching the literature, seeking expert opinions, performing population sampling (Carmines & Zeller, 1979; Netemeyer et al., 2003), or through qualitative research (Hogan et al., 2001). A panel of content experts is then asked to review the potential scale items and validate that they are appropriate indicators of the construct (Schultz & Whitney, 2005).

Any measurement must be reliable – measurement yields consistent, repeatable results and valid – and it measures what it is supposed to measure

(Trochim, 1999). The first is an issue of reliability, the second of construct validity. The internal consistency of single-dimensional additive scales such as in the Felder Model, can be tested using Cronbach's alpha, a coefficient assessing how well a set of items on the scale measures a single "underlying construct" (Messick,1995; Trochim,1999; DeVon et al., 2007). The higher the score, the more reliable the generated scale. The widely accepted social science cut-off is that alpha should be 0.70 or higher for a set of items to be considered a scale, because at $\alpha = 0.70$, the standard error of measurement will be over half of a standard deviation (Nunnaly, 1978; Messick, 1995; DeVon et al., 2007).

4.4 Factors analysis

Factor analysis is performed to identify clusters of items for which responses have common patterns of variation. "Each such cluster, or factor, is denoted by a group of variables, whose members correlate more highly among themselves than they do with variables not included in the cluster" (Nunnaly, 1978; Litzinger et al., 2007). Factor analysis assumes that responses to individual items in an instrument are linear combinations of the factors and it produces a factor model that relates the item responses to the factors in linear combinations (Litzinger et al., 2007).

4.5 Instrument Face and Content Validity

To measure content validity, we drew upon work by Lynn (1986), who computes two types of CVIs. The first type involves the content validity of individual items and the second involves the content validity of the overall scale. There is a considerable agreement about how to compute the item-level CVI, which we refer to for the purpose of clarity as the I-CVI. A panel of content experts is asked to rate each scale item in terms of its relevance to the underlying construct. Lynn (1986) advised a minimum of three experts, but indicated that more than 10 were unnecessary. By tradition, and based on the advice of early writers such as Lynn, as well as Waltz and Bausell (1981), these item ratings are typically on a four-point ordinal scale. Lynn acknowledged that three- or five-point rating scales might be

considered, but she advocated using a four-point scale to avoid having a neutral and ambivalent midpoint.

Lynn (1986) developed criteria for item acceptability that incorporated the standard error of the proportion. She recommended that with a panel of ‘‘five or fewer experts, all must agree on the content validity for their rating to be considered a reasonable representation of the universe of possible ratings’’ (p. 383). In other words, the I-CVI should be 1.00 when there are five or fewer judges. When there are six or more judges, the standard can be relaxed, but Lynn recommended I-CVIs no lower than .78.

Translation of a diagnostic and psychometric instrument for cross-cultural use strives to achieve multiple domains of equivalence to satisfy general goals of maintaining appropriate level of reading comprehension, cultural appropriateness and diagnostic power. It is worth noting here that the struggle to achieve equivalence domains during translation and adaptation is, in fact, similar to efforts expended to establish validity and reliability of the instrument (Rode, 2005; Beauford et el., 2009; Leida et al., 2009). The domains are:

Semantic equivalence when the item has similar meaning in each culture. This includes adaptation of words, sentence structure, idioms in a language that is appropriate to the cognitive, culture and language development of respondents.

Content equivalence when item content is relevant to the population under study. Irrelevant items are substituted by applicable concepts so to convey the intent of the item even if it does not translate literally, i.e. comparable content validity using focus group and ethnographic interviews.

Criterion equivalence when the translated instrument demonstrated the same pattern of relations to independent criteria as that obtained during the validation of the original instrument.

Technical equivalence implies that original and translated instruments should give comparable reliability data as evidence that items and sentence

structures are technically the same, i.e. comparable reliability measures with original instrument.

Conceptual equivalence implies that the item may be translated into different words, but the original meaning of conceptual framework remains intact; the same theoretical construct is evaluated in different cultures involved, i.e. comparable construct validity.

Therefore, development of a translated instrument that satisfies these objectives and establishing its validity and reliability are highly related. Failure to use a culturally sensitive research strategy may compromise validity and reliability of the translated instrument, which may hinder the generalisation of the research findings.

4.6 Suggested translation protocol

In the light of the previous analysis and findings, it is clear that a direct translation of robust psychometric instruments to identify learning styles is not sufficient. Here, we suggested a general protocol for translation and adaptation of instruments intended for cross-cultural use that will improve the reading comprehension of the instrument, reducing cultural sensitivity as well as increasing the validity and reliability of the instrument (Rode, 2005; Beauford et al., 2009).

1. The original instrument is translated by a professional translator.
2. The initial translation is reviewed and evaluated by a bilingual, multi-cultured committee. The expertise in different cultures and in scale development is considered an added value. The translation is amended according to their suggestions until there is consensus about the accuracy and validity of the instrument.
3. The instrument is tested on a small focus group of 3 to 10 bilingual participants as close to the study population as possible. Discussion of item analysis and ethnographic interviews with this focus group result in further

amendment of the instrument as is warranted. Again, multi-culture individuals are better.

4. Back-translation of the instrument is warranted after incorporating all accepted reviews. Changes are compared with original. Any item that did not retain its original meaning is re-translated.
5. To test validity and reliability of a culturally-adapted version, a larger pilot study is run with a sample of 20 to 50 from the target population and descriptive and reliability statistics are compared with the published results of the original instrument.
6. The instrument is applied to the full sample in the research study. The results are evaluated for reliability using Cronbach's alpha. A principal components analysis is performed with each subscale of the instrument, checking for satisfactory loadings on each component within the subscale.
7. Fine-tune the instrument according to validity and reliability results. Items, subscales and factors that do not reach satisfactory levels for the Cronbach's alpha and principal components analysis are removed from further analysis.
8. Cronbach alphas, principal components analysis are used to establish validity and reliability of the resultant instrument for analysis of research questions.
9. Solicit feedbacks at all stages. It is acceptable to explain the statements further in the target language to maintain the level of reading comprehension.

4.7 How to select a random sample

Sampling Methods can be categorised into probability sampling and no probability sampling.

A probability sampling scheme is one in which every unit in the population has a chance (greater than zero) of being selected in the sample, and this probability can be accurately determined. The combination of these traits makes it possible to produce unbiased estimates of population totals, by weighting sampled units according to their probability of selection. Probability sampling includes: Simple Random Sampling, Systematic Sampling, Stratified Sampling, Probability

Proportional to Size Sampling and Cluster or Multistage Sampling (Louis M. Red and Richard A Parker, 1997).

Non probability sampling is any sampling method where some elements of the population have no chance of selection (these are sometimes referred to as 'out of coverage'/'undercovered'), or where the probability of selection cannot be accurately determined. It involves the selection of elements based on assumptions regarding the population of interest, which forms the criteria for selection. Hence, because the selection of elements is non random, non probability sampling does not allow the estimation of sampling errors. These conditions place limits on how much information a sample can provide about the population. Information about the relationship between sample and population is limited, making it difficult to extrapolate from the sample to the population.

Non probability sampling includes: Accidental Sampling, Quota Sampling and Purposive Sampling. In addition, non response effects may turn any probability design into a non probability design if the characteristics of non response are not well understood, since non response effectively modifies each element's probability of being sampled (Louis and Richard, 1997). In this research probability, Cluster or Multistage Sampling is used. Sometimes it is cheaper to 'cluster' the sample in some way, e.g. by selecting respondents from certain areas only, or certain time-periods only. (Nearly all samples are in some sense 'clustered' in time, although this is rarely taken into account in the analysis) (Louis and Richard, 1997).

The population of the Arts and Humanities faculty embraces a number of distinct categories; the frame can be organised by these categories into separate "strata" (Department). There are nine different departments in the Arts and Humanities Faculty: Arabic language and Literature, History, Library and Information Science, Psychology, Islamic Studies, Geography, Mass Communication, European Languages and Literatures and Sociology. Each stratum is then sampled as an independent sub-population, out of which individual elements can be randomly selected. Embraces a number of distinct categories; the frame can

be organized by these categories into separate "strata" (Department). There are five different departments in the Economics and Business Administration Faculty: Public Administration, Accounting, Economics, Political Science, Law and Business Administration. Each stratum is then sampled as an independent sub-population, out of which individual elements can be randomly selected.

We collected the data and the information from the Academic Affairs of regarding Economics and Administration Faculty and the Arts and Humanities Faculty. The data and information are as follows:

1- How many departments are there in each faculty?
2- How many students are there in each faculty (population of each faculty)?
3- How many levels are there in each department of each faculty?
4- What are the courses and sections for all levels of department in each faculty in the first term of 2010?

We used the SPSS programme for uploading the courses and sections for all levels of all departments in each faculty in the first term of 2010, then chose about 10% of courses and sections for all levels of all departments in each faculty in the first term of 2010 by using Random Function, which is available in the SPSS programme.

The sections randomly selected have a value of 1, while the rest have a value of 0. This means different sections will be selected every time we run this procedure. It is noticed also that the sections that have not been selected have a slash through the case number on the left side of the screen. That is, the questionnaires were given to the students chosen randomly from each department. This was done by selecting a random sample of the students from each level (1st year, 2nd year, 3rd year, 4th year), where the total number of students selected should represent 10% of the entire student population in the department.

4.8 Actual Process of Cross-Cultural Adaptation (CCA)

Adaptation of instruments developed in another culture and/or language was limited to a simple translation from the original, or exceptionally, to literal comparison of the original with a back-translation in history. Badia et al, (1995), Berkanovich (1980), Bucquet et al. (1990), Guillemin et al. (1993), Herdman et al. (1997), Patrick et al. (1985), Michael et al. (2007) have been working for some time in different fields, suggesting that semantic evaluation constitutes only one of the steps needed for CCA. Behling (2000), Guillemin et al. (1993), Herdman et al. (1998) and Michael et al. (2007) have recommended that this process should be a combination of a literal translation of words and sentences from one language to another and a meticulous process of fine-tuning that takes into consideration the cultural context and lifestyle of the target population of the translation. Herdman et al., (1998) proposed a basic guide. Assuming the "universalist" stance, they presented an evaluation model for the CCA process that included an assessment of the equivalence between the original instrument and the adaptation. In a subsequent article published in 1998, definitions and details are offered with respect to six types, namely, conceptual, item, semantic, operational, measurement and functional equivalence. A synthesis of the CCA evaluation process is summarised in Table 4.2 (Michael et al., 2007).

Conceptual and item equivalence: this stage covers; the pertinence of the items for picking up each of the domains is evaluated. The discussions take place in the light of a literature review that prioritises publications on the processes involved in developing the source-instrument and the bibliographic material available in the local context. Selected members and individuals representative of the target population should be involved, either through individualised open interviews or through collective activities such as focus groups.

Semantic equivalence: Evaluation of semantic equivalence involves the capacity to transfer the meaning of concepts contained in the original instrument to the translated

version, thereby giving rise to a similar effect among respondents in both cultures. The evaluation guide for this aspect of equivalence should involve several steps, as follows:

1- The process begins with a translation of the original instrument into the language of the target culture. It is suggested that two or more versions should be obtained independently.
2- These versions are then translated back to the original by other translators, also independently.
3- A new bilingual translator formally evaluates the equivalence between the back-translations and the original instrument.
4- The various translation proposals can be managed and debated by going back to the focus groups of the target population. The same group of specialists that took part in the conceptual and item equivalence evaluation stage seeks to identify and address the problems from each of the previous activities.
5- The compiled version of the instrument is applied to groups of individuals from the target population for a thorough evaluation of its acceptability, understanding and emotional impact. One technique to be used in the pretest is to ask the respondents to paraphrase each item, while the interviewer makes a note regarding whether the respondents understood the item referred to or not.

Operational equivalence: Operational equivalence refers to comparison between the characteristics of using an instrument in the target and source populations, such that there is efficacy even if the modus operandi is not the same. It is important to scrutinise the possible influences of certain characteristics of the instruments, such as the layout and format of the questions/instructions (e.g. on printed paper or in electronic format); the application setting (e.g. within a hospital or at home); and the way it is applied (e.g. face-to-face interviews or self-applied). Therefore, it is important to note how the item is categorised and the possible repercussions from choosing particular modifications.

Measurement equivalence: three psychometric focuses can also be suggested: evaluation of the dimensional structure, including adaptation of the component items;

evaluation of information reliability, through a process using the scales under test; and evaluation of the validity of these scales in their diverse nuances such as factor analysis.

Functional equivalence: Provided by the equivalencies identified in the other evaluation stages.

Table 4.2: Main stages involved in evaluating the cross-cultural equivalence of measurement instruments (Michael et al., 2007)

Aspect Evaluated	Evaluation Strategy
Conceptual equivalence	• Literature review involving publications on the culture of the original instrument and the target population
	• Discussion with target population
	• Discussion with specialists
Item equivalence	• Discussion with specialists
	• Discussion with target population
Semantic equivalence	• Translations
	• Back-translations
	• Evaluation of the semantic equivalence between the back-translations and the original
	• Discussion with target population
	• Discussion with specialists for final adjustments
	• Pretest of the translation
Operational equivalence	• Evaluation by research group regarding the pertinence and adequacy of:
	- Layout and format of the questions/instruction
	- Application setting
	- Application mode
	- Categorisation mode
Measurement equivalence	• Psychometric studies:
	- Focus 1: Evaluation of dimensional validity and adequacy of component items
	- Focus 2: Evaluation of reliability
	- Focus 3: Evaluation of the construct validity and criterion validity
Functional equivalence	• Provided by the equivalencies identified in the other evaluation stages

4.9 Procedures for Putting Cross-Cultural Adaptation (CCA) into operation of Arabic Version of the F-S Learning Styles Instrument

A synthesis of the CCA evaluation process of the Arabic version of the Felder-Silverman learning style instrument is summarised in Figure4.1. Each of the steps undertaken in the CCA process is detailed in the following:

Step 1: Literature review involving publications on the culture of the original instrument and the target population (Conceptual equivalence)

The literature review was the key starting point for identifying a suitable psychometric instrument and if there were existing robust translation(s). The Felder-Silverman learning style instrument (FSLSI) was identified and the most suitable for the research (see Aljojo & Adams 2010 and Chapter Three), though after much searching there did not seem to be a suitable Arabic version. There then followed a process of contacting one of the FS-LSI authors (Professor Felder) to check for robust Arabic versions. One Arabic version was identified, though this was a literal translation and not validated. Guidance and permissions were sought from the FS-LSI author on conducting a robust validation of the instrument into Arabic.

Step 2: Translation (Semantic equivalence)

Two independent bilingual translators, competent in both English and Arabic translated the source 44 questions of FS-LSI questionnaire from English into Arabic (see Appendix A). Further Face validity and Content validity was undertaken resulting in differences being identified in some of the translated questions, which did seem to match the original English document nuances and interpretations.

Step 3: Discussion with specialists (Semantic equivalence)

This has the aim of exploring whether the various domains covered by the original instrument in defining the concepts of interest would be relevant and pertinent to the new context for which it is being adapted. Effectively, did the translated questions make sense as translated psychometric concepts? The 44 questions of FS-LSI questionnaire were divided into four different categories according to their dimensions. Questionnaires were then passed to 15 psychologist 'judges', who were asked to evaluate and score each question according to its terms of relevance to the underlying construct (with rating 1 being not relevant, 2 somewhat relevant, 3 quite relevant and 4 highly relevant). After that, the I-CVI is computed for each item as the number of experts giving a rating of either 3 or 4 (thus dichotomising the ordinal scale into relevant and not relevant), divided by the total number of experts. From the 15 sent out, there were 8 detailed responses, which were then collected and used to develop a Content Validity Index (CVI). The translated

instrument went through some fine tuning rewriting on the questions that were not clear and then these were reviewed by the expert psychologists again to check for content validity. This process was repeated until there was a high rating on all questions by the expert psychologists.

Step 4: Back Translation and Evaluation of the semantic equivalence between the back-translations and the original (Semantic equivalence)

In this step, the reviewed Arabic version of the FS-LSI questionnaire was back-translated by another bilingual translator, who was unfamiliar with the original English version to make sure that the original questionnaires were matched. This step assured that the meaning of the Arabic version was reflected in the back-translation version. The review team then rechecked, discussed and revised the items in the back-translated version that did not adequately represent the meaning of the original FS-LSI questionnaire.

Step 5: Pilot testing in the target participants and revision (Measurement equivalence)

This step consisted of applying the Arabic version of the instrument to a selection of female students from three faculties in King Abdul-Aziz University – Arts and Humanities, Economics and Business Administration and Home Economics. This pilot study covered 170 students. Students were encouraged to answer as truthfully as possible and to give feedback especially for vague items, misleading or ambiguous words and to write any comments about the questionnaire in the space provided at the end. All students had difficulty understanding questions 10, 12, 18, 24, 34 and 44. For example, in item numbers 10 and 18 most students could not understand the difference between ‘concepts’ and ‘facts’ and between ‘certainty’ and ‘theory’. This step is mainly covered in Aljojo and Adams (2009) and Chapters Four and Seven.

Step 6: Discussion with participants (Semantic equivalence)

This step included meeting with a group of nine bilingual participants (two being professional bilingual translators) to review the questions. Questions were read to the group in both Arabic and English and discussions followed each question on meaning and interpretation in both languages. Alternative phrases and translations

were reviewed resulting in a refined questionnaire being produced. The refined questionnaire was given to 20 student participants from the Economics and Business Administration Faculty from the same 170 students sample and 30 bilingual student participants from the English department in the Arts and Humanities Faculty. Students were asked about the clarity of the questions and the bilingual participants were further quizzed about the accuracy of the translation.

Step 7: Pilot testing in the target participants and revision (Measurement equivalence)

To estimate the internal consistency reliability of the scores, the Cronbach's alpha coefficient was calculated for each of the four scales of the FS-LSI based on the sample of 20 students for improving Internal Consistency Reliability (this is mainly covered in Aljojo and Adams, 2009 and Chapter Seven). To estimate the internal consistency reliability of the scores, the Cronbach's alpha coefficient was calculated for each of the four scales of the FS-LSI based on the sample of 30 bilingual students from the English department in the Arts and Humanities Faculty. The questionnaires were handed out in English language classes first (and collected), and then the Arabic version was handed out to the same participants This method was used to compare the value of Cronbach's alpha in the English questionnaire with the value of Cronbach's alpha in the Arabic questionnaire (both mainly covered in Aljojo and Adams, 2009 and Chapter Seven). These were then compared with the results of past studies reported by Felder and Spurlin (2005). The Cronbach alpha values obtained in this study show a similar pattern, and are comparable in magnitude to the values obtained in three of the four studies. There are some differences in the pilot study between the groups which may be due to the bilingual group's language ability or to the learning effect from passing the English version first.

Step 8: Literature review involving publications on the culture of the original instrument and the target population (Conceptual equivalence)

The results were further discussed with the FSLST author, particularly the Cronbach alpha values being lower than for the English versions. It appeared that the Arabic students in the pilot were not interpreting some of the questions in the same

way as the English language; for instance, in differentiating between "facts, concepts and theories". This was addressed by including either a definition or an example to each of those words in the questions. Further discussion was undertaken on other questions where there seemed to be slight confusion in meaning (questions 6, 10, 18 and 37). One of the interesting insights from this step is the importance of asking students in a pilot test about the questions and discussing individually with the students their interpretations of the questions.

Step 9: Back Translation and Evaluation of the semantic equivalence between the back-translations and the original (Semantic equivalence)

In this step, after defining concepts, facts and theory and rewriting unclear questions, the reviewed Arabic version of the FS-LSI questionnaire was further back-translated by another bilingual translator who was unfamiliar with the original English version. This step was to ensure the fine tuning did not lose the meaning of the original FS-LSI questionnaire. The review team then rechecked, discussed and revised the items in the back-translated version that did not adequately represent the meaning of the original FS-LSI questionnaire.

Step 10: Pilot testing in the target participants and revision (Measurement equivalence)

A further pilot was conducted on the refined translated instrument to estimate the internal consistency reliability of the scores (again using the Cronbach's alpha coefficient for each of the four scales of the ILS). The sample consisted of 34 students from the Arts and Humanities Faculty and a sample of 56 students from the Economics and Business Administration Faculty (covered in Aljojo and Adams 2010 and Chapter Seven). This resulted in similar Cronbach alpha values to past studies reported by Felder and Spurlin (2005).

Step 11: Final testing in the target participants and revision (Measurement equivalence)

Once happy with the pilot studies, the instrument was piloted on a large sample consisting of 1024 students from the Economics and Business Administration Faculty and the Arts and Humanities Faculty. Comparing the results of the current study with those of past studies reported by Felder and Spurlin (2005), the Cronbach

alpha values obtained in this study show a similar pattern. Factor analysis of the FS-LSI identified eight factors associated with the four scales. Analysis of the underlying construct, with input from psychologist experts, for each of the factors revealed that they are appropriately matched to the intent of the scales, providing evidence of construct validity for the instrument.

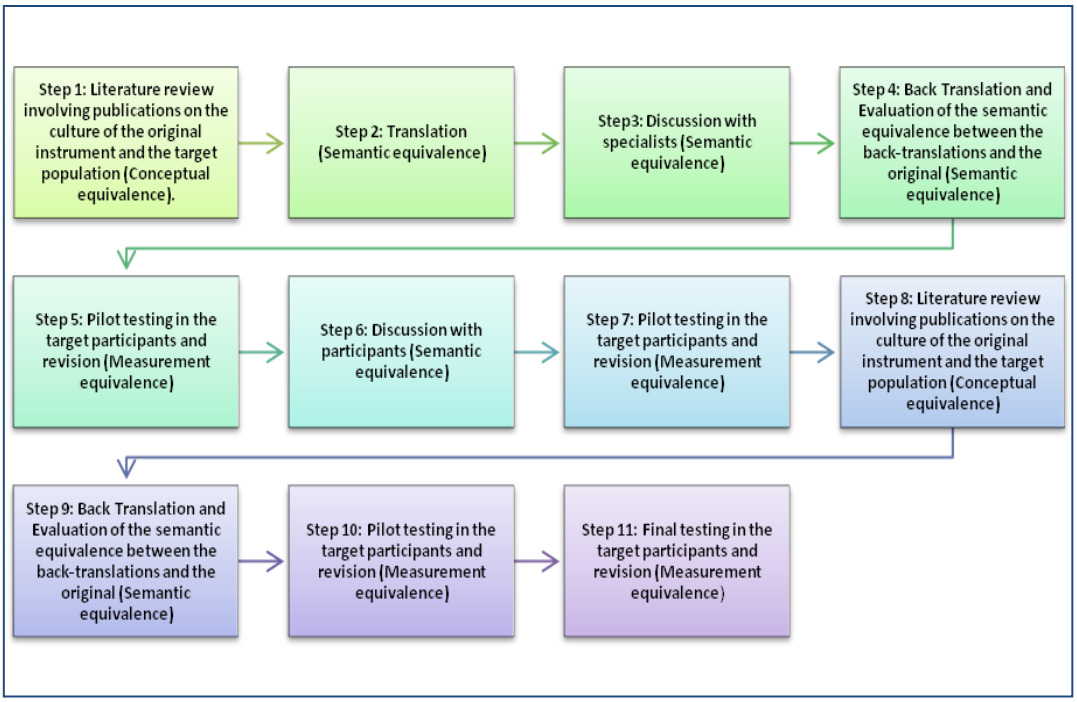

Figure 4.1: A synthesis of the CCA evaluation process of Arabic version of the Felder-Silverman learning style instrument

4.10 Summary

This chapter explored the development of a Scale for content validity of the Arabic version of the ILS by computing a content validity index (CVI), using ratings of item relevance by content experts and Factor analysis. Also, this chapter discussed the development of a translation protocol undertaken to improve the validity and internal reliability of the Arabic version of the ILS, the method of selecting a random sample of the two faculties of Arts and Humanities and Economics and Administration female students in King Abdul-Aziz University in Saudi Arabia, procedures for putting cross-cultural adaptation (CCA) into operation of the Arabic

version of the F-S learning styles instrument and the process of cross-cultural adaptation (CCA).

CHAPTER 5

Teacher Assisting and Subject Adaptive Material (TASAM) Design

5.1 Introduction

Educational research tells us that ‘one size does not fit all’ (Reigeluth, 1996). People have different learning needs which help them retain information: they process and represent knowledge in different ways, they have differing pace and focus in learning activities and they prefer to use different types of resources (Honey and Mumford, 1986). Research suggests that we can actually find the learning style a student is most used to, and when teaching is adapted to this learning style it is more effective (Rasmussen, 1998). Within technology enhanced learning, adaptive educational systems offer an advanced form of learning environment that attempts to meet the needs of different students. Such systems construct a model of the learner’s knowledge, goals and preferences, and use this model to tailor the way the student is taught by adapting the learning environment (Brusilovsky, 2001). Adaptive learning systems have seen an increase in use and popularity due to the more personal experience a learner has with the systems. Existing adaptive systems have been mostly in English aimed at a Western learning environment.

There is much potential benefit in developing adaptive learning environments since it would enable students to follow their course spending less time and obtaining better learning experience (Paredes and Rodriguez,2004) effectively, acquiring knowledge in the most comfortable and efficient learning environment for them. There is also a cost driver in that once a system has been developed then there will be a low marginal cost for extra learners in providing high quality learning support that meets individual needs and preferences.

However, the adaptive learning field is relatively young and it is still unclear which aspects of learning styles are worth modelling, and what would be the best learning support for users with specific learning styles in varying learning contexts. This is a growing and interesting area of learning that is calling for research in developing our understanding of which attributes of learning styles are most useful to model, how the learning material can be adapted to match those learning styles, how

to measure effectiveness of adaptive learning systems and in applying adaptive learning systems to wider contexts and more diverse groups of learners.

The majority of existing adaptive systems have been targeted at Western learners and predominantly English speaking. Consequently there is a need to apply adaptive learning systems to wider learning contexts.

This chapter reports on the development and initial trial of the first Arabic version of an adaptive learning system building on a validated Arabic translation of the Felder and Soloman ILS (Index of Learning Styles) instrument. The Teacher Assisting and Subject Adaptive Material (TASAM) System is used by Arabic speaking undergraduate students on a Statistics course at the King Abdul Aziz University in Saudi Arabia. The chapter discusses the practicality of presenting learning material differently to meet the learning styles of individuals.

Also, this chapter focuses on the Teacher Assisting and Subject Adaptive Material Design (TASAM), specifically, focusing on the Adaptive process of the system, learner model and Content Model, Creating initial System (TASAM), Developing System (TASAM) and TASAM Design and Production. The main outcome of this chapter is the final prototype of TASAM, which is considered an answer to the research question on how an e-learning environment can adapt itself to accommodate individual learning styles.

5.2 The Teacher Assisting and Subject Adaptive Material) Design (TASAM)

This section describes the Adaptive process of the system, creating initial System (TASAM), and developing System (TASAM).

5.2.1 The Adaptive process of the system

The procedure is as follows: firstly, the student fills in the questionnaire; then the score obtained points out the active-reflective, the sensing-intuitive, visual/verbal and the sequential-global preference of the student: mild, moderate or extreme. Finally, we use that preference to construct a learner model, together with other student characteristics. The learning style data are used to adapt the content

sequencing in case of mild, moderate and extreme score and assign a suitable adaptive course (see Figure 5.1).

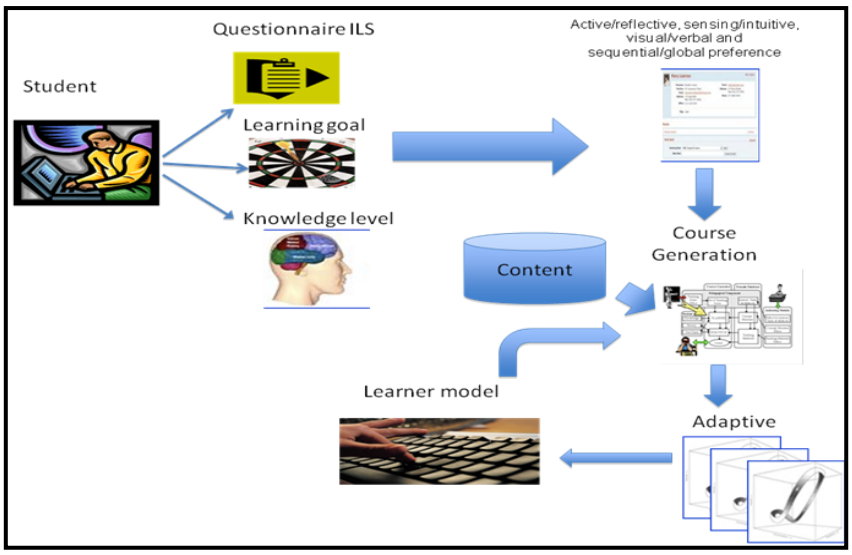

Figure 5.1: Adaptive process

5.2.2 Creating the initial System (TASAM)

Based on Felder-Silverman Learning Style Theory, classification of student learning styles and their implementation rules are defined. The system is assigned to distinguish the default preferences for those mild, moderate and strong preferences of learning style dimensions. There are 16 different types of combination of learning style dimensions (Kinshuk and Lin, 2003). See Table 5.1.

Table 5.1: 16 types of combination of leaning style dimensions

Combination of leaning style dimensions
active/sensing/visual/sequential
active/sensing/visual/global
active/sensing/verbal/sequential
active/sensing/verbal/global
active/intuitive/visual/sequential

active/intuitive/visual/global
active/intuitive/verbal/sequential
active/intuitive/verbal/global
reflective/sensing/visual/sequential
reflective/sensing/visual/global
reflective/sensing/verbal/sequential
reflective/sensing/verbal/global
reflective/intuitive/visual/sequential
reflective/intuitive/visual/global
reflective/intuitive/verbal/sequential
reflective/intuitive/verbal/global

These different learning styles are implemented by the use of the following eight elements, and the rules for their implementation are discussed (Graf, 2007; Kinshuk and Lin, 2003).

- Active: study in discussion groups, guessing possible questions and answers.
  - ✓ Providing a discussion area.
  - ✓ Reminding students to guess several possible questions.
  - ✓ The number of exercises is increased and self-assessment tests are given at the start and finish of each chapter.
  - ✓ Active learners tend to be less receptive to examples, since they only show how others have done them and do not attempt it themselves. Therefore, a small number of examples are presented for active learners.
- Reflective: stop periodically to think about something before going ahead
  - ✓ Review what they have been learning.
  - ✓ Writing summaries.
  - ✓ Think before going ahead.

- ✓ The number of elements asking for active behaviour (such as exercises and self-assessment tests) should decrease.
- ✓ It is recommended first to present the learning material in terms of content objects so that learners can reflect on it, and afterwards to show examples or ask them to do some tasks based on the learned material.
- ✓ We provide outlines additionally between the topics and a conclusion straight after all the content in order to prompt the learners to reflect on the already learned material.

❖ Sensing: facts, examples following by the exposition, hands-on work, practical material.

- ✓ Example first followed by the exposition.
- ✓ Prefer to learn from examples. Therefore, the number of examples should increase for sensing learners and examples should be presented before the abstract learning material.
- ✓ Hands-on work, such as practice.
- ✓ Sensing learners also prefer practical problem solving; the number of exercises should therefore increase.
- ✓ Providing tasks such as exercises and self-assessment tests after the learning material.

❖ Intuitive**:** abstract, concept, theory, exposition before example.

- ✓ Exposition first and followed by the example.
- ✓ More concept and abstract challenges; tasks like self-assessment tests and exercises can be presented before the learning material.
- ✓ The number of examples and exercises should decrease.

❖ Visual: picture, graphs, diagram, flow chart, plans, demonstration.

- ✓ Concept map, colour notes, slides with multimedia.
- ✓ More picture, graphs, diagram.
- ✓ Animated demonstrations.
- ✓ Colour important concepts.

- Verbal: text and audio.
  - ✓ Text.
  - ✓ Audio.
- Sequential: sequential learners prefer to learn in easy steps with a linear increase of complexity. They are more interested in a predefined sequential learning path than in getting the overview of the course.
  - ✓ In order.
  - ✓ Step by step to present material.
  - ✓ Constrict links.
- Global: Large picture before detail, large jump, context of the subject.
  - ✓ Give big picture of the course.
  - ✓ Provide all the links at once.

To date, 16 types of learning styles and their corresponding implementation rules have been formulated. Following the work done by Carver (Car, 1999) and using a similar approach that takes advantage of the versatility offered by teaching the tools of the agent`s environment built by means of a multiagent architecture (MASPLANG) environment, the teaching content and navigation tools were adapted to match learning styles. Adapting some traditional instructional strategies and building the learning object by using HTML pages which have subjects embedded in different media formats (Tables 5.2 and 5.3) offers a useful distribution of criteria for selecting the right instructional strategies, media format and navigation tools for adaptive presentation. As can be seen in Tables 5.2 and 5.3, the instructional strategies, media formats and navigation tools proposed could cater for almost all learning styles. In any case, the reason the components were identified previously is to be able to offer the learning content and the learning environment that best fits the learning profile obtained via the ILS questionnaire

Table 5.2: Adaptive concept or example by selecting navigation tools (Pe˜na et.al, 2005)

	Punctuals			Structurals		Collaborative work		
	Arrows (back & forward)	Printings	On-line help	General vision map	Filters	Chat	Forum	e-mail
Active	√	√		√	√	√	√	√
Reflective	√	√	√	√	√			√
Sensing	√	√	√	√	√	√	√	√
Intuitive	√	√	√	√	√	√	√	√
visual	√	√	√	√	√	√	√	√
verbal	√	√	√	√	√	√	√	√
Sequential	√	√	√			√	√	√
Global				√	√	√	√	√

Table 5.3 adaptive concept or example by selecting media format (Pe˜na et.al, 2005)

Dimensions	Slideshow		Mediaclips		Lineal Text
	text	multimedia	Graphics	Audio	
Active					✓
Reflective	✓				✓
sensing		✓	✓	✓	✓
intuitive	✓	✓	✓	✓	✓
visual		✓	✓		
verbal	✓			✓	✓
Sequential	✓	✓		✓	✓
Global			✓		

5.2.3 Developing System (TASAM)

A learning style is defined as 'the characteristics, strengths and preferences in the way people receive and process information' (Felder & Silverman, 1988). It refers to the idea that each person is different, and as such prefers to learn in different

ways. Sewall (1986) identifies several theories about learning styles, but focused on four specific learning style evaluation instruments to conduct a study on. They were chosen as they seemed particularly suitable for using to support adaptive learning systems, these being Myers-Briggs Type Indicator, Kolb's Learning Style Inventory, Canfield's Learning Style Inventory and Gregorc's Type Indicator (Franzoni & Assar, 2009).

For this study we have selected the Felder and Silverman model as the basis of our taxonomy of adaptive teaching for the following reasons: it has been successfully implemented in previous works when individually adapting the electronic learning material (Carver, Howard & Lane, 1999), (Hong & Kinshuk, 2004), (Paredes & Rodriguez, 2002); it has been approved by its author and other specialists (Felder & Spurlin, 2005); practicality - it is user friendly and the results are easy to interpret, the number of dimensions is controlled and can actually be implemented (Paredes & Rodriguez, 2002).

Felder and Silverman's LST uses a sliding scale to formulate an individual's preferred learning. It takes into account four dimensions: sensing-intuitive, visual-verbal, active-reflective and sequential-global (Felder and Silverman, 1988; Felder, 1993). As shown in Table 5.4.

Table 5.4: Felder Learning Styles Dimensions

Description	**Dimension**		**Description**
Learn by working in groups and handling stuff.	Active (A)	Reflective (Re)	Learn better when they can think and reflect on the information presented to them. Work better alone or with one person at most.
Prefer to deal with facts, raw data and experiments; they are patient with details, but do not like complications.	Sensing (S)	Intuitive (I)	Prefers to deal with principles and theories, are easily bored when presented with details and tend to accept complications.
Easy for them to remember what they see: images, diagrams, time tables, films, etc.	Visual (Vi)	Verbal (Ve)	Remember what they have heard, read or said.
Follow a lineal reasoning process when solving problems and can work with a specific material once they have comprehended it partially or superficially	Sequential (Seq)	Global (G)	Take big intuitive leaps with the information, may have difficulty when explaining how they got to a certain result, need an integral vision.

In order to design an adaptive learning system, both the learning strategies of the users and the teaching strategies of the educators are key factors which must be accounted for. Individual learning strategies are the strategies used to remember, learn and use information. In this case, the responsibility is with the student (comprehension and text writing, problem solving, etc.). Students must go through a process where they recognise the new information, review previous ideas, organise and restore that previous knowledge, match it with the new one and interpret everything that was seen on the subject. Teaching strategies (TS) are the elements given by the teachers to the students to give them a better understanding of the information.

The emphasis is on the design, programming and accomplishment of the learning content. Teaching strategies must be appealing to students so that they feel encouraged to observe, analyse, express opinions, create hypotheses, look for solutions and discover knowledge by themselves. One example is the didactic teaching strategy which refers to an organised and sequential set of activities and resources called upon by the teacher when teaching. The main idea is to make learning easier for the student. Among the different components of a teaching strategy, we can mention the development of the learning process, how and with what it is achieved. Some of the previous studies worth mentioning are those of Dunn (1988), who emphasises the importance of teaching students by using methods that adapt to their conceptual preferences, and Cabrero (2006), who points out how the applied teaching strategies will take effect on the teaching quality, not only from an individual point of view, but also in terms of the collaboration of the group as a whole. One essential aspect of this chapter is the integration of electronic media with teaching strategies: ICT allows a mix of different media expanding practical teaching strategies. For instance, Table 5.5 collates possible teaching strategies with learning styles. This is further translated to the use of different media as represented in Table 5.6.

Table 5.5: Possible Teaching strategies (TS) and Learning Styles (Franzoni et al., 2008; Franzoni et al., 2009)

		Learning styles							
		Sensitive	Intuitive	Visual	Verbal	Active	Reflexive	Sequential	Global
Teaching strategy	Games and simulations		X	X		X			
	Learning based on problem solving	X				X			
	Role playing		X			X			X
	Presentation	X		X			X	X	
	Discussion panel		X		X	X			
	Brainstorming				X	X			X
	Case study		X				X		X
	Question and answer method	X			X		X	X	
	Project design method		X			X			X

As the table above shows, there can be one or many teaching strategies that accommodate one learning style. Also, learning styles hold a one-to-many relationship with electronic media. For each learning style, there are one or many teaching strategies that can be implemented by one or many electronic media based on an associated learning style.

Table 5.6: Adaptive taxonomy: Possible Electronic Media and Learning Styles (Franzoni et al., 2008, Franzoni et al., 2009).

			Learning styles							
			Sensitive	Intuitive	Visual	Verbal	Active	Reflexive	Sequential	Global
Electronic media	Audio	Audio recording				X			X	
		Audio conference				X			X	
	Collaboration	Forums	X		X		X			X
		Online learning communities			X					X
		Weblog or blog	X				X			X
		Wikis	X		X		X			X
	Communication	Chat					X			X
		Email					X			X
	Diagrams	Animation	X		X					
		Graphics	X		X					
		Pictures	X		X					
		Simulation			X					
	Read	Digital magazines						X	X	
		Digital newspapers						X		
		eBooks			X			X	X	
		Hypertext (web pages)			X			X	X	
		Slideshows						X	X	X
	Search	Internet research		X				X		
	Tutoring	Course Legacy system		X						
		Student Response system								
		Tutorial systems		X				X		
		Web Quest		X				X		
	Video	Podcast				X		X		
		Recorded live events			X	X				
		Videoconference			X	X				
		Videos			X	X				
		Web seminars (broadcasts)								

An adaptive teaching taxonomy that ties up learning styles with teaching strategy and electronic media is the basis of any adaptive learning system centred around individual learning styles. The taxonomy in Table 5.7 shows the different learning styles, with teaching strategies, suggesting suitable electronic media to

represent and access learning material. This taxonomy has been constructed based on an evaluation of Soloman-Felder learning style theory and usage of e-media. It also builds on previous work, such as Franzoni et al. (2008), which used an expert panel adopting the Delphi method held during the III Congreso de Estilos de Aprendizaje at Cáceres (Spain) in July 2008.

The TASAM system determined the appropriate teaching strategy and media format to adaptive course material of statistics. See Tables 5.7 and 5.8. However, in terms of Global scale, there is no appropriate teaching strategy, so for the students with a global learning style preference, pages comprised elements such as a table of contents, summary, diagrams, overview of information and jump from page to page, etc. For sequential students, the pages contained small chunks of information, text-only pages with 'forward' and 'back' buttons.

Table 5.7: Adaptive taxonomy: LS dimensions and EM relationships for course material of statistics.

			Learning styles							
			Sensitive	Intuitive	Visual	Verbal	Active	Reflexive	Sequential	Global
Electronic media	Audio	Audio recording				X			X	
	Communication	Chat					X			X
		Email					X			X
	Diagrams	Graphics	X		X		X			
		Pictures	X		X		X			
	Read	Slideshows			X			X	X	
	Search	Internet research		X			X	X		
	Tutoring	Tutorial systems		X				X		

Table 5.8: Adaptive taxonomy: LS dimensions and TS relationships for course material of statistics

		Learning styles							
		Sensitive	Intuitive	Visual	Verbal	Active	Reflexive	Sequential	Global
Teaching strategy	Learning based on problem solving	X				X			-
	Presentation	X		X			X	X	-
	Discussion panel		X		X	X			-
	Question and answer method	X			X		X	X	-

5.4 TASAM design and production

This section focuses on System Architecture, domain model, learner model and adaption model

5.4.1 System Architecture

Internet information services 7 (IIS 7), SQL server 2005 and Active Server Pages 3.5 (ASP 3.5) and window server have been used in order to develop the system. These technologies were used because of their faster reaction for dynamic web application and because the communication between them tends to be perfect. TASAM utilised the following software versions:

1. Internet information services 7 (IIS 7)
2. SQL server 2005
3. Active Server Pages 3.5 (ASP 3.5)
4. Windows server 2008

The main characteristic of TASAM is that it can be adapted to the learning style. The system was organised in the form of three basic components: the domain model, the learner model and the adaptation model. These three components interacted to adapt different aspects of the instructional process. Figure 5.2 illustrates the system architecture.

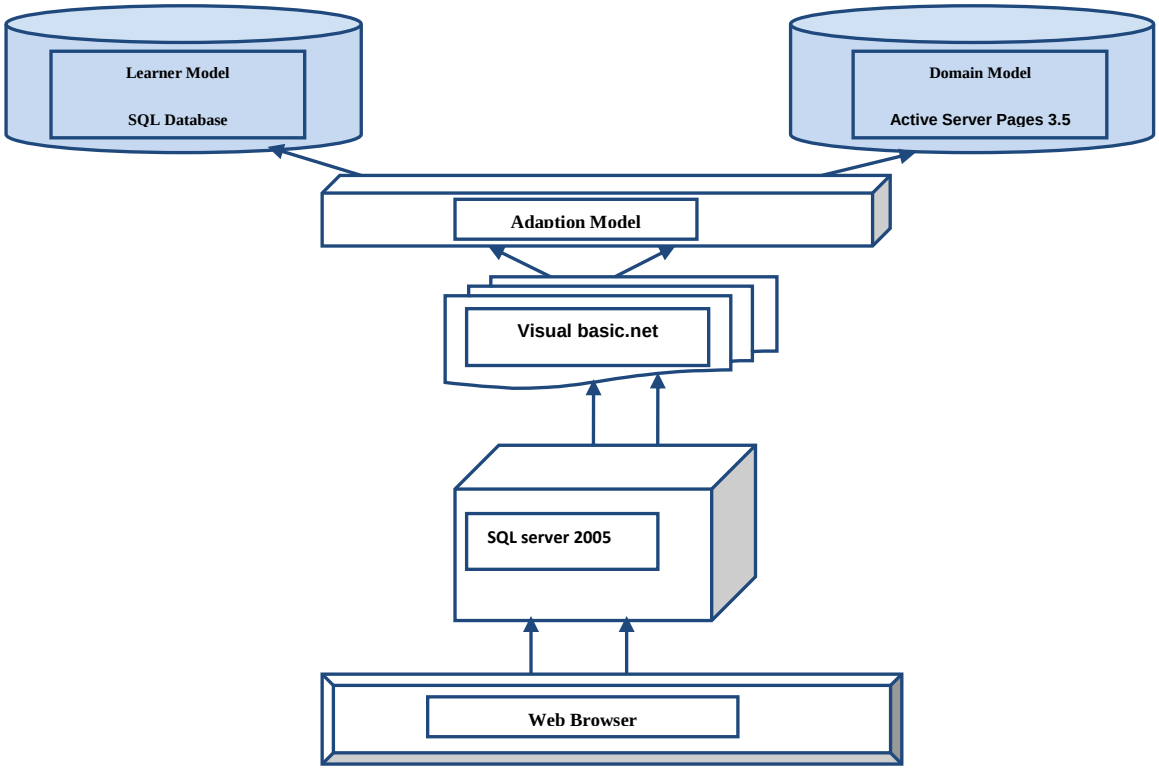

Figure 5.2: Illustrating the System Architecture.

When learners enter TASAM for the first time, they sign up by using a registration form. Once a learner registers, a learner profile will be created to store all his/her information. This will be saved in the database, and a unique identification (ID) is generated for the learner. Then, he/she will submit the answered questionnaire to get the results that will show his/her learning style. TASAM uses an Arabic version of the Felder and Soloman (1997) Index of Learning Styles (ILS) to generate the learning profile, which consists of a personal preference for each of the four dimensions of FSLSM expressed with values between +11 to -11 per dimension (see Figures 5.3 & 5.4).

Figure 5.3: Screenshot of Index Learning styles questionnaires

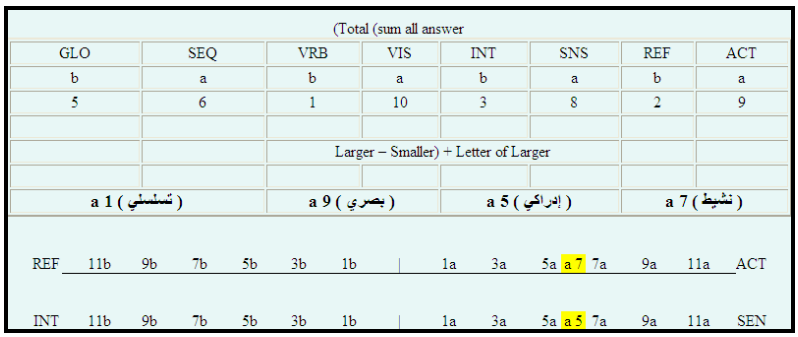

Figure 5.4: Screenshot of the result of learning style

TASAM adapts the content sequencing of the course material to match the learning style profile for the student. Figure 5.5 shows a snapshot of the navigation and content areas. The lesson contents appear in the navigation area as tree-like structure of hyperlinks, whilst in the content area the learning content is presented by the media matched for the learner preference.

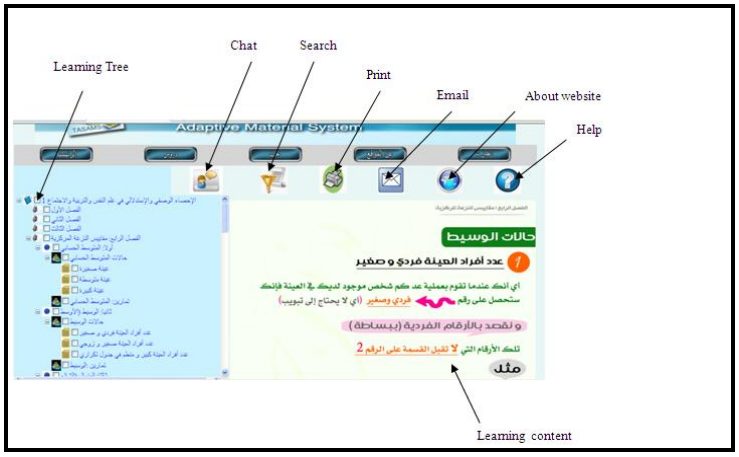

Figure: 5.5 Screenshot of adaptive course of statistics

TASAM offers many signs to prevent the learner from getting lost. First, the learning tree shows already visited pages in a different colour (purple instead of blue). Second, the learner typically progresses through TASAM in a hierarchical manner. As the learning tree grows, new pages will be added below the last branch. The new branch expands and the first content page is displayed when the learner enters a new lesson. Finally, link annotations are added to learning contents to show the currently viewed content pages. Appendix D shows a TASAM system tutorial.

Learning tree: The learning content was accessible in a hierarchical, tree-like fashion with the aid of a collapsible Active Server Pages tree menu.The tree grew with the progression of the learner.

Intra lesson navigation: A small navigation bar offered “previous” and “next” arrows for the content pages of the current lesson.

Learning content: The central screen area was reserved for the learning content, presented in the different teaching strategies and electronic media.

Email: The email icon to send email for any person.

Chatting: The chat icon for chatting with other people.

Print: The print icon for printing the lessons of the course.

Help: For browsing the tutorial of the website.

5.4.2 Prototype of Teacher Assisting and Subject Adaptive Material System (TASAM)

Based on the learning style description by Felder-Silverman Learning Style, the following learning style representation in a hypermedia environment was compiled. The majority of these elements apply to the layout, sequencing and structure as well as the navigation of the user interface. The two principal considerations in designing hypermedia courseware to accommodate preferred learning styles are: the way in which the information is formatted and structured and how individuals process the given information. Hypermedia can be an advantage or disadvantage for the users depending on whether the material is matched or mismatched with the students' preferences. The way that active/sensing/visual sequential students process information would appear to be directly relevant to effective learning from information presented as hypermedia. For active/ sensing/visual/ sequential students, the pages contained Audio, Email, Graphics, Pictures, Slideshows, Internet research and 'forward' and 'back' buttons (see Figure 5.6).

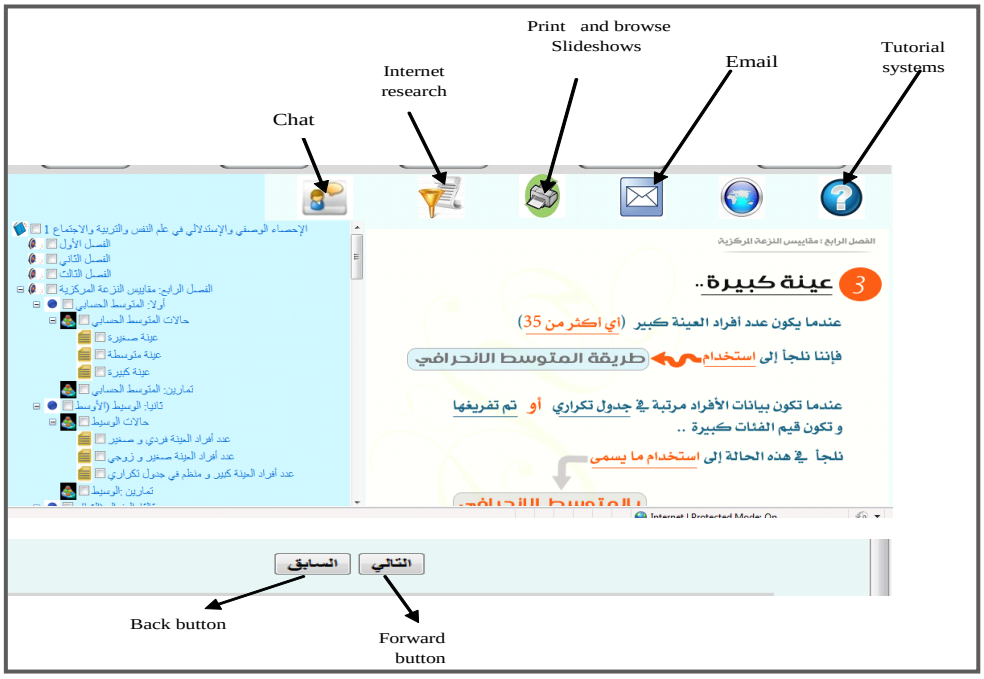

Figure 5.6: Screenshot active/sensing/visual/ sequential students

5.4.3 Domain model

We organised each chapter of statistics material by using instructional design theories (Elaboration theory and Component Display Theory – CDT). Each chapter is generated for a learning goal and organised around specific outcome concept. Each outcome concept is associated with specific learning outcomes as well as with prerequisites and related concepts by using Elaboration Theory (Reigeluth and Stein, 1983).

On a micro level the learning content was structured according to Merrill's component display theory (CDT) (1994). CDT was one of the first instructional design theories that separated content from instructional strategy. Therefore, it was an important contribution to the field of educational technology (Kovalchick & Dawson, 2002; wolf 2003). The theory comprises four primary presentation forms: rules (general form), instances (concrete examples), practice and recall. A secondary layer of components includes prerequisites, objectives, helps, mnemonics and feedback. According to CDT, instruction is most effective if all primary and secondary components are present in the instructional materials. In line with CDT, learners should be able to select and jump between components that best suit their needs and preferences. See Table 5.9.

Table 5.9: Components of an Exemplary TASAM learning Sequence

Component	TASAM equivalent content
Objective	Content page: Objective of each related concept
Example	Content page: Example of each related concept
Elaboration	Content page: Summary of each related concept
Elaboration	Content page: Outline of each related concept
Practice	Content page: Practice of each related concept
Recall	Content page: Test end of each related concept
feedback	Correct answers of test

The concept for providing adaptivity is based on representing specific course elements, or topics, grouped into chapters for a course. The courses chosen to apply the TASAM adaptive system were short introductory statistic courses aimed at first level undergraduates across one faculty at the King Abdul-Aziz University in Saudi Arabia: the Arts and Humanities Faculty. The Statistics topic was chosen for several reasons. First, expert-refined and validated learning materials were available, which were kindly provided by the evaluation questionnaire of teacher. Second, it was a relatively straightforward task to re-design the materials of a Statistics-related topic for a computer-based environment. Third, Statistics was considered a timely and desirable learning objective for potential participants. Lastly, a Statistics course is an abstract topic, which provides opportunities to develop different representations for the same concept by employing different electronic media. The statistics TASAM system ran between 2010 and 2011. Content improvement suggestions and general feedback was collected from participating tutors and students. The Statistics topic is shown in Appendix C.

5.4.4 Learner model

A distinct feature of an adaptive e-learning system is the learner model it employs; that is, a representation of information about an individual learner. Learner modelling and adaptation are strongly correlated, in the sense that the amount and nature of the information represented in the learner model depend largely on the kind of adaptation effect that the system has to deliver.

The learner model in TASAM represents the knowledge of the system about the learner. It reflects several characteristics of the learners and supports the communication between learner and system. In our approach, the learner model includes general information about the learner, his/her dominant learning style, username, password, unique ID, age and e-mail. The learning style state stores values for objects concepts to match learners' learning style, that is, media type. It associates a number of learner preferences with each object concept of the domain sub-model resources structures.

5.4.5 Adaptation model

The adaptation model in TASAM specified the way in which learning style modifies the presentation of the content. It was implemented as a set of the classical structure: if condition, then action type rules. These rules form the connection between the domain model and learner model to update the learner model and provide appropriate learning materials. Also, the TASAM system determined the appropriate teaching strategy and media format to adaptive course material of statistics. Following Kinshuk and Lin (2003), moderate and strong preference were grouped together to enable 16 types of combination of leaning style dimensions from which representation templates were generated (see table 5.1). This provided the basis for enabling learners with different learning styles to view different presentations of the same educational material (Aljojo and Adams 2009). The analysis of Table 5.10 is illustrated in the following; overall recommendations are presented to select teaching strategy and e-media material for each learning style.

Sensitive Learning Style: The content must be practical; the courses must have an immediate connection with the real world, using concrete methods that are oriented towards facts and procedures that follow previously established techniques. The requested homework must be detailed, not global, and include problem solving, laboratory exercises and concept memorisation.

Teaching Strategy: Problem solving based learning (Exercises and Self-Tests)

Electronic Media: Graphics, and Pictures.

Intuitive Learning Style: The content must be innovative, oriented to theory and meanings, with abstractions and mathematical formulae, and avoid repetitive methods. The requested homework must include the discovery of relations and actions. The introduction of new concepts can be used but not as memorising facts but as abstractions.

Teaching Strategy: Discussion Panel

Electronic Media: Internet research, Tutorial systems

Visual Learning Style: The content must be heavy on visual components. The requested homework must include actions to visualise, the information gathering must use visual representations, images must be used in order to make it easier for

the students to remember the contents and the teacher can request diagrams that summarise the homework.

Teaching Strategy: Presentation

Electronic Media: Slideshows, Graphics, and Pictures

Verbal Learning Style: The content must have many oral and textual components. The requested homework must include written essays or oral presentations, the information gathering must use textual representations, texts must be used in order to make it easier for the students to remember the contents and the teacher can request abstracts that summarise the homework.

Teaching Strategy: Discussion Panel, Question and Answer method (Examples)

Electronic Media: Audio recoding

Active Learning Style: Students tend to comprehend and assimilate new information when they practise using it (discussion, implementation, group presentations) and prefer working with others. The content must be applicable. The requested homework must include work in groups.

Teaching Strategy: Discussion Panel, Problem solving based learning (Exercises and Self-Test).

Electronic Media: Chat, Email, Graphics, Pictures.

Reflexive Learning Style: Students observe and ponder experiences. Data are collected and analysed thoroughly before any conclusion is made. The content must be related to experiences. The requested homework must include personal work.

Teaching Strategy: Question and Answer method (Examples), Presentation

Electronic Media: Internet research, Tutorial systems, Slideshow.

Sequential Learning Style: The content must be written in an orderly manner, step by step. The requested homework must consist of small orderly steps that are logically associated with the problems being solved. This allows content to be shown in steps (chapters).

Teaching Strategy: Presentation, Question and Answer method (Examples)

Electronic Media: Audio recording, Slideshow

Global Learning Style: The content must be written in big leaps, suddenly and almost randomly. Students can solve complex problems quickly and put things

together in an innovative way, but may have difficulties explaining how they did it. Global scale does not find any appropriate teaching strategy from table 5.5 because the teaching strategies such as Brainstorming, Case study and Project design method are very difficult to apply to students of the first level of statistics. Therefore, for the students with a global learning style preference, pages comprised elements such as a table of contents, summary, diagrams, overview of information and jump from page to page.

Electronic Media: Chat, Email

Figure 5.7 is a lesson for the learning style-active/sensing/visual/sequential. The active student can enter the group discussion area anytime through the menu, and use chat and email buttons. For sequential, the lesson is presented step by step with ‘forward’ and ‘back’ buttons. According to the visual and sensing, the lesson is presented with picture, Graphics and highlighting the important concepts. The sequential and visual students can browse the lessons as slideshows with audio and use print button to print the slideshows by using PowerPoint application.

Sensing learners prefer to learn concrete material such as data and facts, as well from examples, the number of examples is increased. Also, as learners like practical problem solving, the number of exercises is increased. Moreover, sensing learners prefer to solve such problems according to already learned approaches. Therefore, providing tasks such as exercises and self-tests only after the learning material is recommended.

According to FSLSM, active learners prefer to learn by trying things out and doing something actively. Therefore, the number of exercises is increased and self-tests are presented at the end of a chapter. Moreover, active learners tend to be less interested in examples, since they show how others have done something rather than let them do it themselves. Therefore, a small number of examples were presented for active learners. Sequential learners prefer to learn in linear steps with a linear increase of complexity, presenting first the learning material, then some examples.

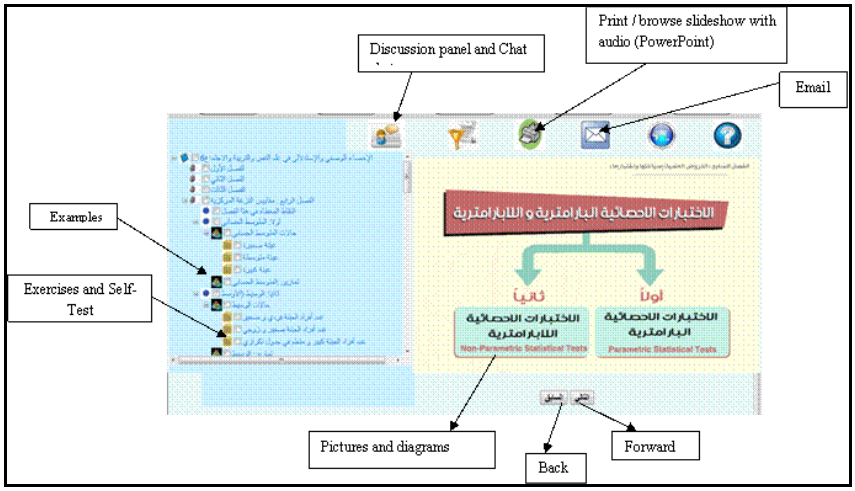

Figure 5.7: A screenshot of a lesson for leaning style active/sensing/visual/sequential

Figure 5.8 is a lesson for the learning style active/sensing/visual/global, which is the same lesson for the learning style active/sensing/visual/ sequential, but there is a difference in the global learning style. For the global learner, it is very important to get the big picture of the course. This is supported by providing additional outlines between the topics, presenting a summary straight after the content and a table of contents. Also, global learners had more navigational freedom such as jump and back/forward buttons.

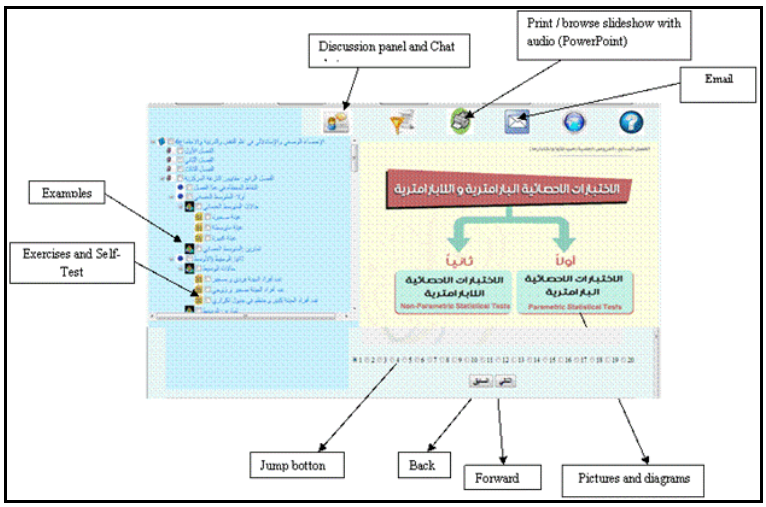

Figure 5.8: A screenshot of a lesson for learning style active/sensing/visual/global

Figure 5.9 is a lesson for the learning style active/sensing/verbal/ sequential, which is the same lesson for the learning style active/sensing/visual/ sequential. Figure 5.10 is a lesson for the learning style active/sensing/verbal/global, which is the same lesson for the learning style active/sensing/visual/ global. However, there is a difference in the verbal learning style; verbal learners get more out of textual representations, regardless of whether they are written or spoken. Accordingly, the verbal learner can enter the group discussion area anytime through the menu. In addition, the verbal learner can browse the lessons as slideshows with audio and use the print button to print the slideshows via the PowerPoint application.

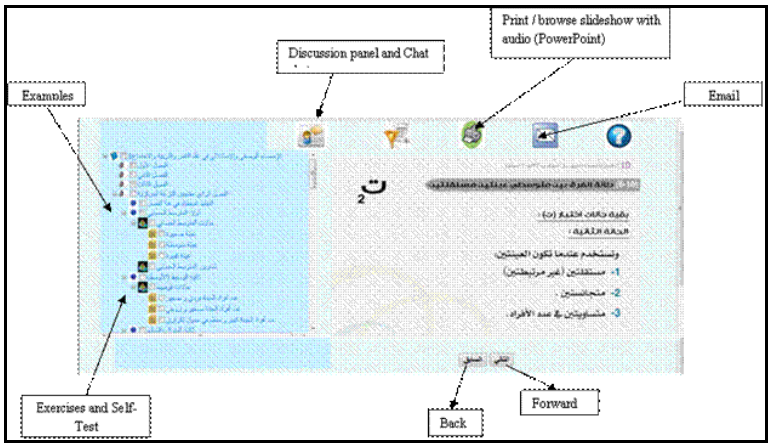

Figure 5.9: A screenshot of a lesson for leaning style active/sensing/verbal/sequential

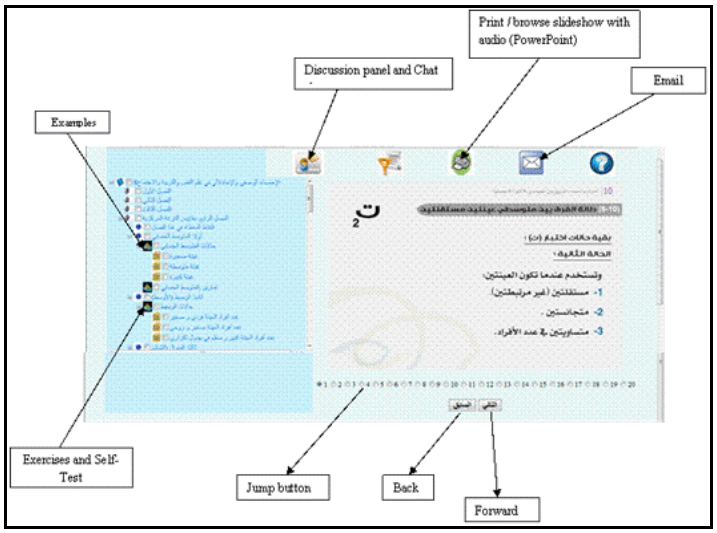

Figure 5.10: A screenshot of a lesson for learning style active/sensing/verbal/global

A lesson for the learning style active/intuitive/visual/sequential is the same lesson for the learning style active/sensing/visual/sequential. A lesson for the learning style active/intuitive/visual/global is the same lesson for the learning style active/sensing-visual/global.

A lesson for the learning style active/intuitive/verbal/sequential is the same lesson for the learning style active/sensing/verbal/ sequential. Also, a lesson for the learning style active/intuitive/verbal/global is the same lesson for the learning style active/sensing/verbal/global. However, there is difference in the intuitive learning style (see Table 5.10 and Appendix F). The intuitive learner can enter the group discussion area anytime through the menu, and use Internet research and tutorial system electronic media for learning.

A lesson for the learning style reflective/intuitive/visual/sequential is the same lesson for the learning style active/intuitive/visual/sequential. A lesson for the learning style reflective/intuitive/visual/global is the same lesson for the learning style active/intuitive/visual/global. A lesson for the learning style reflective/intuitive/verbal/sequential is the same lesson for the learning style active/intuitive/verbal/sequential. A lesson for the learning style reflective/intuitive/verbal/ global is the same lesson for the learning style active/intuitive/ verbal//global. However, there is a difference in the reflective learning style.

A lesson for the learning style reflective/sensing/visual/sequential is the same lesson for the learning style active/sensing/visual-sequential. A lesson for the learning style reflective/sensing/visual/global is the same lesson for the learning style active/sensing/visual/ global. A lesson for the learning style-reflective/sensing/verbal/sequential is the same lesson for the learning style active/sensing/verbal/sequential. A lesson for the learning style reflective/sensing/verbal/global is the same lesson for the learning style active/sensing/verbal/global. However, there is a difference in reflective learning style instead of active learning style.

Reflective learners prefer to learn by reflecting on the learning material and thinking things through. Therefore, the number of elements asking for action (such as exercises and self-tests) is decreased. Furthermore, the learning material is presented in terms of content objects so that learners can reflect on it and afterwards examples are shown or they are asked to do some tasks based on the learned material. Also, the reflective learner can browse the lessons as slideshows with audio, select the print button to print the slideshows via the PowerPoint application and use Internet research and tutorial system electronic media for learning. Appendix F and table 5.10 show the other figures of lessons for learning style.

Table 5.10: Adaptive taxonomy: LS dimensions, EM relationships and TS relationships for each of the learning styles combinations

Learning styles	Teaching Strategy				Electronic Media							Navigation tools	
	Problem solving based learning (Exercises and Self-Tests)	Discussion Panel	Presentation	question and answer method (Examples)	Graphics and Pictures	Internet research	Tutorial systems	Slideshows	Audio recoding	Chat	Email	Back/Forward	Jump button
Active/Sensing/Visual/Sequential	√	√	√	√	√			√	√	√	√	√	
active/sensing/visual/global	√	√	√	√	√			√	√	√	√	√	√
active/sensing/verbal/ sequential	√	√	√	√	√			√	√	√	√	√	
active/sensing/verbal/global	√	√	√	√	√			√	√	√	√	√	√
active/intuitive/visual/sequential	√	√	√	√	√	√	√	√	√	√	√	√	
active/intuitive/visual/global	√	√	√	√	√	√	√	√	√	√	√	√	√
active/intuitive/verbal/sequential	√	√	√	√	√	√	√	√	√	√	√	√	
active/intuitive/verbal/ global	√	√	√	√	√	√	√	√	√	√	√	√	√
reflective/intuitive/visual/sequential		√	√	√	√	√	√	√	√			√	
reflective/intuitive/visual/ global		√	√	√	√	√	√	√		√	√	√	√
reflective/intuitive/verbal/sequential		√	√	√		√	√	√	√			√	
reflective/intuitive/verbal/ global		√	√	√		√	√	√	√	√	√	√	√
reflective/sensing/visual/sequential	√		√		√	√	√	√				√	
reflective/sensing/visual/ global	√		√		√	√	√	√		√	√	√	√
reflective/sensing/ verbal/ sequential	√	√	√	√	√			√	√			√	
reflective/sensing/ verbal/ sequential	√	√	√	√	√			√	√	√	√	√	√

5.5 Summary

This chapter gave an answer to the research question on how an e-learning environment can adapt itself to accommodate individual learning styles specifically, focusing on the technical details of TASAM implementation. Finally, this chapter discussed TASAM Design and Production specifically, focusing on its System Technologies and Software and System Architecture. The system was organised in the form of three basic components: the domain model, the learner model and the adaptation model. These three components interacted to adapt different aspects of the instructional process.

CHAPTER 6
EXPERIMENTAL DESIGN AND EVALUATION

6.1 Introduction

Technology enhanced learning solutions offer the potential to provide learning environments specifically tailored to an individual. Technology can enable learners to acquire knowledge and skills at a time, place and pace that are appropriate for their own particular circumstances. Technology can also present the learning material in a format most suitable to an individual's learning preference, aims and objectives.

Adaptive hypermedia research has received more attention during the last two decades. However, it is still unclear which aspects of learning styles are worth modelling, and what can be done differently for users with different learning styles. An adaptive e-learning hypermedia is an approach whose target is to personalise the learning experience for the learner (De Bra et al., 2004; Henze and Nejdl, 2004). A number of adaptive educational systems have been developed based on learning styles as a source for adaptation, including: AEC-CS (Trantafillou et al., 2002), INSPIRE (Grigoriadou et al., 2001), iWeaver (Wolf, 2003), MASPLANG (Peña et al, 2002; Peña, 2004), LSAS (Bajraktarevic et al, 2003), EDUCE (Kelly, 2005) and ILASH (Bajraktarevic et al., 2003a). One of the key challenges in such adaptive learning systems is the development of robust experimental evaluation mechanisms to assess their impact on students' achievement. For instance, Brown et al. (2009) investigated adaptive e-learning hypermedia that specially utilises learning style as their adaptation mechanism. They found that out of 10 systems, 6 systems did not seem to have published any quantitative evaluations in their recent research. Typical examples would be AES-CS (Triantafillou et al., 2003) and INSPIRE (Papanikolaou et al., 2003), which uses some empirical data in the form of descriptive statistics but no inferential statistics testing. Also, the number of users was relatively small (n = 10 and n = 23, respectively).

A common evaluation approach involves comparing performance on an adaptive learning system with non-adaptive versions for different cohorts of users. However, there are many challenges with comparing non-adaptive with adaptive version of learning systems (De Bra, 2000). Any difference between the groups' performances might be attributed to users' features (e.g. Initial knowledge, goals) or wider environment.

The following sections 6.2 and 6.3 propose an answer to the research question concerning the impact on learning performance of the student when learning materials are matched and mismatched with learning styles of a student. This chapter discusses issues of evaluation and how to measure effectiveness of adaptive learning systems. It specifically focuses on the Trial Test System (TASAM), Initial evaluation and assessment of the adaptive learning system by students and tutors, Final Test System (TASAM) and final evaluation and assessment of the adaptive learning system by students.

6.2 Test System (TASAM)

Development of the TASAM adaptive learning system involved rendering and refining the existing learning material on the Statistics course into different representations and learning subtasks for use within the adaptive taxonomy of learning styles dimensions and multimedia. This involved considerable consultation and participation from the statistics tutors across faculties and examination of the learning material for consistency and correctness. In addition, the TASAM system involved the development of a student registration and logging system involving students working through an online Arabic version of the LSI for their individual assessment of learning styles. The system contained details of the LSI, along with the students' learning styles assessment, for interest and explanation of the system.

6.2.1 Participants and Study Design

6.2.1.1 Trial Test System (TASAM)

The initial running and testing of the TASAM system took place in the main laboratory of the faculty of Economics and Administration in King Abdul-Aziz University, after the mid exams of the second semester (academic year 2010-2011) All the computers used in the experiment were connected to the Internet and participants accessed the TASAM website through a common web browser. Participants consisted of eighty students from the Arts and Humanities Faculty and were organised into three different groups: a) students using the TASAM system with no professor explanation of the chapter; b) students using the TASAM system with professor explanation of the chapter; and c) students not using the TASAM system and only using the professor explanation of the chapter. Each group took a pre-test of the topic area before using the experiment and group B and group C had the same professor.

The first groups consisting of twenty-two students were given the chapter covering the T-Test topic to work through in TASAM with no professor explanation. Students were given information and guidance on how to use the TASAM system in their first class, along with asking them to fill out the ILS questionnaires online. Each student was aware of his or her learning style. A pre-test related to T-Test chapter was given before they started using the adaptive learning system (all students received zero scores covering T-Test and poor scores for descriptive stats indicating initial low levels of knowledge – which was expected at the start of the course). The class sessions lasted about an hour and a half with comments and feedback on the system taken at the end of the sessions with further comments via email (generally the students liked the system). The second group consisted of eighteen students that were given the T-test chapter in the TASAM system but also had teacher explanation of the topic area. Other than the tutor explanation of the topic the processes were the same as the first group (e.g. registration and adaptive representation of material). The third group consisted of 40 students who were given teacher explanation of the

chapter only (i.e. without using the TASAM adaptive system). Development and testing of the system involved limited use covering specific topics or chapters within the statistics course (the T-Test and descriptive statistics) and used by a selected group of students. This enabled refinement of the system before the more comprehensive set of topics were incorporated into the system.

At the end of the initial experimentation (the pre-test and post testing), results were compared to examine the impact of the adaptive learning styles on student performance. These are given in sections 7.4, 7.5, 7.6, 7.7 and 7.8 (Chapter Seven). In analysing the responses to the knowledge questions, the scores for the two session types suggested that there was a very strong relationship between matching students learning style to the statistics course; the findings suggest that all the students achieved significantly higher scores while browsing the session that matched their learning styles. There are differences achievements scores among the three groups mean adaptive of learning style impact on learning performance of student, that all the students achieved significantly higher scores while browsing the session that matched their learning styles. Each of the three groups in the system testing was engaged in using one chapter within the statistics course (see the following Table 6.1):

Table 6.1: Procedures of the trial test of TASAM system

Groups	Number of Participants	Statistics chapters covered	Students not using the TASAM system and only using the professor's explanation	Students using the TASAM system with no professor explanation	Students using the TASAM system with professor explanation
Group A	22	T.Test		√	
Group B	18	T.Test			√
Group C	40	T.Test	√		

Testing comparisons consisted of the following:

1- Compared Group (B) with Group (A).The same chapter, but different groups.
2- Compared Group (A) with Group (C). The same chapter, but different groups
3- Compared Group (B) with Group (C). The same chapter, but different groups.

The hypothesis will be covered in detail in Chapter Seven, section 7.4, and mainly covered in Aljojo et al. (2011) and Aljojo and Adams (2010).

H0: group (B) will learn significantly better than group (A).
H1: group (A) will learn significantly better than group (C).
H2: group (B) will learn significantly better than group (C).

6.2.1.2 Final Test System (TASAM) in the first semester

Testing of the TASAM system took place in the main laboratory of the Economics and Administration Faculty in King Abdul-Aziz University, after the mid exams of the first semester (academic year 2010-2011). All the computers used in the experiment were connected to the Internet and participants accessed the TASAM website through a common web browser. Participants consisted of 53 students from the Arts and Humanities Faculty and were organised into two different groups (see the following Table 6.2):

1. Group (D) consisted of 28 students; the group (D) has four different cases.
    - Group(D), Case 1: students using the TASAM system with no professor explanation of the chapter (Measures of Variability and Correlation).
    - Group(D), Case 2: students not using the TASAM system and only using the professor explanation of the chapter (Central tendency)
    - Group (D), Case 3: students using the TASAM system with professor explanation of the chapter (Measures of Variability and Correlation).
    - Group(D), Case 4: students using the TASAM system with no professor explanation of the chapter (Correlation).

2. The group (E) consisting of 25 students, group (E), has three different cases.
    - Group(E), Case 1: students using the TASAM system with no professor explanation of the chapters (Measures of Variability and Central tendency statistics)
    - Group(E), Case 2: students not using the TASAM system and only using the professor's explanation of the chapter (Correlation)
    - Group (E), Case 3: students using the TASAM system with the professor's explanation of the chapters (Measures of Variability and Central tendency statistics).

Table 6.2: Procedures of test of TASAM System in the first semester

Groups	Number of Participants	Cases of each groups	Stats chapters covered	Students not using the TASAM system and only using the professor's explanation	Students using the TASAM system with no professor explanation	Students using the TASAM system with professor explanation
Group D	28	Case 1	Measures of Variability and Correlation		√	
		Case 2	Central tendency	√		
		Case 3	Measures of Variability and Correlation			√
		Case 4	Correlation		√	
Group E	25	Case 1	Measures of Variability and Central tendency		√	
		Case 2	Correlation	√		
		Case 3	Measures of Variability and Central tendency			√

Testing comparisons consisted of the following:

1- Compared Group (D), Case 1 with Group (D), Case 2. The chapters are different, but the same group.
2- Compared Group (D), Case 1 with Group (D), Case 3. The same chapters and group.
3- Compared Group (E), Case 1 with Group (E), Case 2. The chapters are different, but the same group.
4- Compared Group (E), Case 1 with Group (E), Case 3. The same chapters and group.
5- Compared Group (D), Case 4 with Group (E), Case 2. The same chapters, but different groups.

The hypothesis will be covered in detail in Chapter Seven (section 7.6) and mainly in Aljojo et al. (2011) and Aljojo and Adams (2010).

H3: Group (D), Case 1 will learn significantly better than Group (D), Case 2

H4: Group (D), Case 1 will learn significantly better than Group (D), Case 3

H5: Group (E), Case 1 will learn significantly better than Group (E), Case 2

H6: Group (E), Case 1 will learn significantly better than Group (E), Case 3

H7: Group (D), Case 4 will learn significantly better than Group (E), Case 2

6.2.1.3 Final Test System (TASAM) in the second semester

Testing of the TASAM system took place in the main laboratory of the Economics and Administration Faculty in King Abdul-Aziz University, after the mid exams of the second semester (academic year 2010-2011). All the computers used in the experiment were connected to the Internet and participants accessed the TASAM website through a common web browser. Participants consisted of 30 first levels of statistics students from the Arts and Humanities Faculty, organised into one group.

Students were given information and guidance on how to use the TASAM system in their first class, along with asking them to fill out the ILS questionnaires online. Each student was aware of his or her learning style. A pre-test related to the Measures of Central tendency chapter was given before they started using the adaptive learning system (all students received poor scores covering Measures of Central tendency indicating initial low levels of knowledge – which was expected at the start of the course). The class sessions lasted about an hour and a half with comments and feedback on the system taken at the end of the sessions with further comments via email (generally the students liked the system). Participants consisted of 30 students from the Arts and Humanities Faculty and were organised into one group. The chapters are different, but the same group.

1. Group (F) has two different cases. See the following Table 6.3:
   - Group (F), Case 1: using the TASAM system with no professor explanation of the chapters (Measures of Central tendency and Measures of Variability).
   - Group (F), Case 2: not using the TASAM system and only using the professor explanation of the chapter (Correlation).

Table 6.3: Procedures of Test of TASAM System in the second semester

One group	Number of Participants	Cases	Stats chapters covered	Students not using the TASAM system and only using the professor explanation	Students using the TASAM system with no professor explanation
Group F	30	Case 1	Measures of Variability and Central tendency		√
		Case 2	Correlation	√	

Testing comparisons consisted of the following:

1- Compared the Group (F), Case 1 with the Group (F), Case 2

The hypothesis will be covered in detail in Chapter Seven (section 7.8) and mainly in Aljojo et al. (2011) and Aljojo and Adams (2010).

H8: Group (F), Case 1 will learn significantly better than Group (F), Case 2

6.3 Evaluation and assessment of the adaptive learning system by students of Test System (TASAM)

There are two types of evaluations: formative evaluation, used to improve the materials; and summative evaluation, used to improve the learning process. The formative evaluation was created by surveying teachers and students. Summative evaluation is used to test the finished product (Gal, 2001, Peña, 2004). This research is based on both of these types of evaluation. The students were surveyed using a questionnaire, which allowed us to evaluate:

1. The students' opinions about the system (TASAM).
2. If TASAM was successful in explaining the information related to the statistics course.
3. The importance of the learning environment and learning material that was offered.
4. The degree of difficulty of TASAM.
5. The TASAM system's technical support.
6. The motivation to continue the education.
7. Learning based on problem solving (Example): this teaching strategy contains examples that convey a given idea. It can be used for almost any learning style, but mainly for the sensor and active style which prefers a practical approach to concepts. Questions 3, 14 and 17 in the evaluation questionnaire assess this teaching strategy.
8. Question and answer method: this teaching strategy contains questions that could be provided as hints during the interactive mode. There are two different types of questions: simple yes/no questions given at the end of each chapter, and more open-ended questions at the end of each section that require a student to elaborate on their problem solving. This strategy is

important because it enables students to question their problem solving ability. This is most effective on “reflective” type learners as it prompts them to reflect on their abilities. It is also helpful for sensing, verbal and sequential learners as they will most likely look at the relationships between differing aspects of the questions, and the steps involved in creating the solution. Questions 3 and 17 in the evaluation questionnaire assess this teaching strategy.

9. Electronic Media: this electronic media contains audio, communication, diagrams, read, search and tutoring. Audio recording is used for the verbal and sequential questions, number 3 and 10 in the evaluation questionnaire. Communication: this electronic media contains chat, messenger and email. It is used in the active and global questions 12 and 3 of the evaluation questionnaire. Diagrams: this electronic media contains graphics and pictures and is used by visual and sensing type learners. Read: this electronic media contains hypertext web pages and slideshows and is used for the visual, reflective and sequential learners. Questions 3 and 17 in the evaluation questionnaire assess this aspect. Search: this electronic media contains Internet research. It is helpful for intuitive, active, reflective and global learners. Tutoring: this electronic media contains a tutorial system, which is useful for global, intuitive and reflective learners.
10. Navigation tool: this media format contains jump buttons and ‘forward’ and ‘back’ buttons, which are useful for global learners. However, the ‘forward’ and ‘back’ buttons are also useful for sequential learners. Questions 3 and 18 in the evaluation questionnaire assess this aspect.

In addition, feedback consisting of informal student comment directly after using the system along with formal feedback in survey form from staff and students was taken to monitor the progress and development of the system.

6.3.1 Initial evaluation and assessment of the adaptive learning system by students and tutors of Initial Test System (TASAM)

We evaluated the TASAM system in two phases: first presenting the perceptions of teacher and students by using the information obtained through the surveys. The evaluation questionnaire was answered by four teachers, who used the TASAM teaching environment. Overall, teachers seemed to have enjoyed using the TASAM system and there seemed to have been a positive impact on learning performance. Furthermore, the evaluation questionnaire was answered by 32 students, who used the TASAM teaching environment (see Chapter Seven). The questionnaire can be found in Appendix B.

The feedback from the evaluation questionnaire confirms that the students felt the system was useful and interesting, but the idea was dynamic and it made education easy. The students carried out the learning activities with the motivation of a good final mark. In comparison, the feedback from the teachers' evaluation questionnaire suggests that, overall, the students enjoyed using the TASAM system and there seemed to have been a positive impact on learning performance (see Chapter Seven, section 7.5).

6.3.2 Final evaluation and assessment of the adaptive learning system by students in the first semester

The first evaluation questionnaire was answered by 112 students, who learned the material from the site related to learning styles (www.adaptivelearningstyle.com). The second evaluation questionnaire was answered by 110 students, who used the TASAM teaching environment.

The feedback from the overall students suggests that they enjoyed using the TASAM system and there seemed to have been a positive impact on learning performance (see Chapter Seven, section 7.7). The questionnaire can be found in Appendix B.

6.3.3 Final evaluation and assessment of the adaptive learning system by students in the second semester

The second evaluation questionnaire was answered by 130 students, who used the TASAM teaching environment. The feedback, overall, suggests that the students enjoyed using the TASAM system and there was a positive impact on learning performance (see Chapter Seven, section 7.8). The questionnaire can be found in Appendix B.

6.4 Summary

The chapter has described in detail the testing of the adaptive learning system Teacher Assisting and Subject Adaptive Material System (TASAM) – in the first and second semester. It also described issues of evaluation and how to quantify the effectiveness of the trial test system (TASAM), initial evaluation and assessment of the adaptive learning system by students and tutors, final test System (TASAM) and final evaluation and assessment of the adaptive learning system by students.

CHAPTER 7
FINDINGS AND ANALYSIS OF DATA

7.1 Introduction

This chapter considers the reliability and validating of the Felder-Soloman Index of learning Styles in Arabic, specifically focusing on its Content Validity Index (CVI), and the results and discussion of the reliability of the ILS Questionnaire.

Chapter Seven presents in detail the results and discussion of the trial test, as well as the results and discussion of the final test system (TASAM) in the first and second semester. Also the chapter covers the initial evaluation and assessment of the adaptive learning system by students and teacher and the final evaluation and assessment of the adaptive learning system by students in the first and second semester.

7.2 A Study of the Reliability and Validating the Felder-Soloman Index of Learning Styles in Arabic.

This section argues that Scale developers should indicate which method was used to provide readers with interpretable content validity information. Also, it discusses the internal reliability of the Arabic version of the ILS questionnaire, which was applied to a selection of 1024 female students in two faculties from the King Abdul-Aziz University in Saudi Arabia. The Arts and Humanities and Economics and Administration faculties cover a range of degrees and topic interests and are, consequently, likely to include students with a range of learning style preferences.

7.2.1 Content Validity Index (CVI)

In addition to the translation from English to Arabic, the questionnaires were reviewed by expert psychologists to check for content validity in the Arabic form. The 44 questions of the ILS questionnaire were divided into four different categories according to their dimensions. Questionnaires were passed to 15 psychologist ‘judges’ who were asked to write their comments, if they had any, and to rate each

scale item according to its terms of relevance to the underlying construct (with rating 1 being not relevant, 2 somewhat relevant, 3 quite relevant and 4 highly relevant). After that, the I-CVI is computed for each item as the number of experts giving a rating of either 3 or 4 (thus dichotomising the ordinal scale into relevant and not relevant), divided by the total number of experts. From the 15 sent out, there were 8 detailed responses, which were then collected and used to develop a Content Validity Index (CVI). There are two ways to calculate the S-CVI/Ave, which we illustrate in Table 7.1. The first, as just explained, averages the proportion of items rated relevant across experts. Thus, we can calculate S-CVI/Ave as (.48 +.89+.80+.93+1.0+1.0+1.0+.81)/8 = .86. Another way is to average the I-CVIs by summing them and dividing by the number of items. The two computations will always yield the same results (Polit and Beck, 2006).

Table 7.1: Fictitious Ratings on a 44-Item Scale by Eight Experts: Items Rated 3 or 4 on a 4-Point Relevance Scale.

Items	Expert1	Expert2	Expert3	Expert4	Expert5	Expert6	Expert7	Expert8	Number in Agreement	Item CVI
1	X	X	X	X	X	X	X	X	8	1
2	X	X	X	X	X	X	X	X	8	1
3	_	X	_	X	X	X	X	X	6	0.75
4	_	X	_	X	X	X	X	_	5	0.63
5	X	X	X	X	X	X	X	X	8	1
6	X	X	X	X	X	X	X	X	8	1
7	_	X	X	X	X	X	X	X	7	0.88
8	_	X	X	X	X	X	X	X	7	0.88
9	_	_	_	X	X	X	X	X	5	0.63
10	_	X	X	X	X	X	X	_	6	0.75
11	_	X	X	X	X	X	X	X	7	0.88
12	X	X	X	X	X	X	X	X	8	1
13	_	_	X	X	X	X	X	X	6	0.75
14	_	_	X	X	X	X	X	X	6	0.75
15	_	X	X	X	X	X	X	X	7	0.88
16	X	X	X	X	X	X	X	X	8	1
17	X	X	X	_	X	X	X	X	7	0.88
18	_	X	X	X	X	X	X	_	6	0.75

19	_	X	X	X	X	X	X	_	6	0.75
20	X	X	X	X	X	X	X	X	8	1
21	X	X	X	X	X	X	X	X	8	1
22	X	X	X	X	X	X	X	X	7	0.88
23	X	X	X	X	X	X	X	X	8	1
24	_	X	X	X	X	X	X	X	7	0.88
25	_	_	_	_	X	X	X	X	4	0.5
26	_	X	X	X	X	X	X	_	6	0.75
27	_	X	X	X	X	X	X	X	7	0.88
28	_	X	X	X	X	X	X	_	7	0.88
29	X	X	X	X	X	X	X	X	8	1
30	X	X	_	X	X	X	X	X	7	0.88
31	X	X	X	X	X	X	X	X	8	1
32	_	X	X	X	X	X	X	X	7	0.88
33	X	X	_	-	X	X	X	X	6	0.75
34	X	X	_	X	X	X	X	X	7	0.88
35	_	X	X	X	X	X	X	X	7	0.88
36	X	X	X	X	X	X	X	X	8	1
37	-	X	-	X	X	X	X	X	6	0.75
38	X	_	X	X	X	X	X	X	7	0.88
39	X	X	X	X	X	X	X	X	8	1
40	X	X	X	X	X	X	X	X	8	1
41	X	X	X	X	X	X	X	X	8	1
42	_	X	_	X	X	X	X	_	5	0.63
43	_	X	X	X	X	X	X	_	6	0.75
44	_	X	X	X	X	X	X	X	7	0.88
Proportion Relevant									Mean I-CVI =	0.86
	0.48	0.89	0.8	0.93	1	1	1	0.81	Mean expert Proportion=	0.86

7.2.2 Results and Discussion of Reliability of ILS Questionnaire (Pilot Study)

7.2.2.1 Internal Consistency Reliability

This section consisted of applying the Arabic version of the instrument to a selection of female students in King Abdul-Aziz University in Saudi Arabia, representing three faculties – Arts and Humanities, Economics and Business

Administration and Home Economics – to form a pilot study covering 170 students. To calculate the internal consistency reliability, Cronbach's alpha coefficient was calculated for each of the four scales of the ILS based on the sample of 170 students for the pilot study. The value of Cronbach's alpha was low as represented in Table 7.3.

Table 7.2: Descriptive Statistics

Scale	N	Mean	Std. Deviation
active	170	5.92	1.81
sensing	170	7.45	1.75
visual	170	7.62	2.29
sequential	170	5.99	1.79

Table 7.3: Cronbach alpha values for weakest item removed from each scale

Scale	Alpha Value 11 items	Alpha Value 10 items	N
Active- Reflective	0.314	0.379	170
Sensing- Intuitive	0.361	0.408	
Visual- Verbal	0.629	0.645	
Sequential- Global	0.329	0.358	

7.2.2.2 Test-Retest Reliability

In estimating test-retest reliability, the same test is administered to the same or similar sample, on more than one occasion. The time between the measurements is very important. Normally, the longer the time gap, the lower the correlation. In the study, the time lapse was five weeks, with Table 7.4 showing a moderate to strong correlation between the test and the retest scores. Also, in Table 7.4, the correlation was higher for visual, sequential and active learners than sensing.

Table 7.4: Pearson's Correlation of Test-Retest Scores for the ILS

Active Scores	Sensing Scores	Visual Scores	Sequential Scores
.519**	.378**	.743**	.532**
N = 31	N = 31	N = 31	N = 31

Table 7.5 shows the results of Paired-Samples t-test, revealing that there was no significant difference between the test-retest mean scores. However, the difference between the means of Sensing scores was not borderline significant (*P* = 0.162) and the correlation between the two Sensing scores was the first lowest, at 0. 378. (Table 7.5). Yet, the use of such standard statistical tools may be in fact misleading as a predictor of stability of the scales, in this case of the Sensing scale. Homogeneity or heterogeneity of scores affect score reliability since a small change in raw scores leads to large changes in rankings and thus low correlation of the scales.

Table 7.5: Paired Samples Statistics of Test-Retest Scores for the ILS (N=31)

		Mean	N	Std. Deviation	Std. Error Mean	T	df	Sig(2-tailed)
Pair 1	ACT_before	6.1613	31	1.55127	0.27862	-0.614	30	0.544
	ACT_after	6.3226	31	1.42331	0.25563			
Pair 2	SEN_before	7.1613	31	1.50769	0.27079	-1.434	30	0.162
	SEN_after	7.5806	31	1.40888	0.25304			
Pair 3	VIS_before	8.4839	31	2.23414	0.40126	-2.033	30	0.051
	VIS_after	9.0323	31	1.79785	0.3229			
Pair 4	SEQ_before	5.8387	31	1.73391	0.31142	-0.217	30	0.829
	SEQ_after	5.9032	31	1.68037	0.3018			

7.2.2.3 Improving Internal Consistency Reliability

This section included meeting with a group of nine bilingual participants (two being professional bilingual translators) to review the questions. Questions were read

to the group in both Arabic and English and discussions followed each question on meaning and interpretation in both languages. Alternative phrases and translations were reviewed resulting in a refined questionnaire being produced. The refined questionnaire was given to 20 student participants from the Economics and Administration Faculty from the same sample of 170 students. The Cronbach's alpha coefficient was calculated for each of the four scales of the ILS based on the sample of 20 students for improving internal consistency reliability. The Cronbach's alpha coefficient was calculated for each of the four scales of the ILS before explaining the difficulty understanding questions 10, 12, 18, 24, 34 and 44 for students (see Table 7.6). Also, the Cronbach's alpha coefficient was calculated for each of the four scales of the ILS after explaining the difficulty understanding questions 10, 12, 18, 24, 34 and 44 for students (see Table 7.7).

Table 7.6: Cronbach alpha values before explaining non-clear questions

Scale	A-R	S-N	V-V	S-G	N
Cronbach Alpha Value	0.521	0.362	0.503	0.119	20

Table 7.7: Cronbach alpha values after explaining non-clear questions

Scale	A-R	S-N	V-V	S-G	N
Cronbach Alpha Value	0.675	0.45	0.549	0.382	20

7.2.2.4 Internal Consistency Reliability

The Cronbach's alpha coefficient was calculated for each of the four scales of the ILS based on the sample of 30 bilingual students from the English department in the Arts and Humanities Faculty. The questionnaires were handed out in English first (and collected) then the Arabic version was handed out to the same participants. This method was used to compare the value of Cronbach's alpha in the English questionnaire with the value of Cronbach's alpha in the Arabic questionnaire – which were both high (see Tables 7.8 and 7.9).There are some differences in the pilot

between the groups which may be due to the bilingual group's language ability or to the learning effect from passing the English version first.

Table 7.8: Cronbach alpha values for Arabic questionnaire version

Scale	A-R	S-N	V-V	S-G	N
Cronbach Alpha Value	0.502	0.763	0.656	0.509	30

Table 7.9: Cronbach alpha values for the English questionnaire version

Scale	A-R	S-N	V-V	S-G	N
Cronbach Alpha Value	0.496	0.66	0.564	0.46	30

7.2.2.5 Internal Consistency Reliability

A further pilot was conducted on the refined translated instrument to estimate the internal consistency reliability of the scores (again using the Cronbach's alpha coefficient for each of the four scales of the ILS). The sample consisted of 34 students from the Arts and Humanities Faculty and a sample of 56 students from the Economics and Business Administration Faculty. See Tables 7.10 and 7.11 and Aljojo et al. (2009).

Table 7.10: Cronbach alpha values for Arts and Humanities Faculty (pilot study)

Scale	A-R	S-N	V-V	S-G	N
Cronbach Alpha Value	.427	.557	.663	.563	34

Table 7.11: Cronbach alpha values for Economics and Business Administration Faculty (pilot study)

Scale	A-R	S-N	V-V	S-G	N
Cronbach Alpha Value	.432	.578	.669	.414	56

7.2.2.6 Factors Analysis

Exploratory factor analysis was conducted. The first step was to estimate the number of factors in the ILS using a "scree plot" of the eigenvalues, which is shown in Figure 7.1. In the scree plot, the Eigenvalues are plotted in order from the largest to the smallest value. The Kaiser-Gutman criterion (eigenvalue > 1) indicates that there are more than four factors in the ILS (Zywno, 2003; Litzinger et al., 2005).

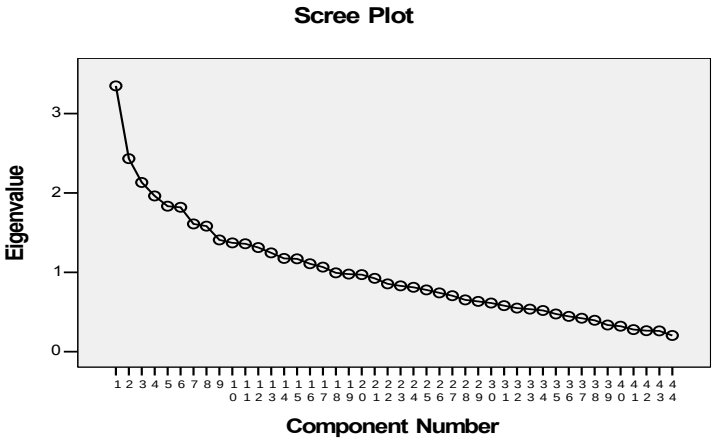

Figure: 7.1. Scree Plot for Factor Analysis on ILS Scores (n =170)

A series of factor analyses were performed with four to eight factors. For each of the analyses, the Visual-Verbal scale maintained consistent structure, with all seven items consistently loading on a single factor. The other scales were found to relate to more than one factor. The results from the eight factor solution are summarised in Table 7.12.

A review of the items related to each of the factors was finished to found the nature of the factors, which are summarised in Table 7.12. The Sequential-Global scale consists of five factors, preference for sequential over random or holistic thinking and emphasis on details over the "big picture." The Sensing – Intuitive scale consists of six factors, Preference for concrete information or abstraction. Finally, the Active-Reflective scale has four factors related to action or reflection as an initial approach, being outgoing or reserved in social situations, and favourable or unfavourable attitude towards group work.

Table 7.12: Factors in the eight factor solution

Scale	#F	Items	Factors
Active-Reflective	1	1, 9,13,17,21,29	Outgoing or reserved Favourable or unfavourable attitude towards group work
	6	33,37,41	
	3	5	
	4	25	
Sensing - Intuitive	1	38	Preference for concrete information (facts, data, the "real world") or abstraction (interpretations, theories, models)
	2	8,14,34	
	3	42,26	
	4	2,22,30	
	5	10	
	6	18	
Visual-Verbal	1	7,11,15,19,31,35,39	Information format preferred for input, Information format preferred for memory or recall
	2	43	
	5	3,27	
	8	23	
Sequential-Global	2	24,36	Linear/sequential or random/holistic thinking Emphasise details (the trees) or the big picture (the forest)
	3	4,8,20,28	
	5	16	
	7	32,40	
	8	12,44	

The factor analysis provides data of construct validity for the ILS. The strongest evidence is for the Visual-Verbal scale, for which seven items load on a single factor and the Cronbach alpha is high. For the Active-Reflective, Sensing – Intuitive and Sequential-Global scales the identified factors appear to be appropriate for the scales. However, the relatively low values of the Cronbach alphas for these three scales indicate that their factors are not as strongly correlated. Eight items were identified in the factor analyses that do not load effectively onto any of the eight factors. The result of factors analysis is not accurate because the Cronbach alpha value is very low. The correlation between the four scales should be minimal (see Table 7.13).

Table 7.13: Correlation matrix of four dimensions

		active	sensing	visual	sequential
active	Pearson Correlation	1	0.143	.164(*)	0.044
	Sig. (2-tailed)	.	0.062	0.032	0.572
	N	170	170	170	170
sensing	Pearson Correlation	0.143	1	-0.045	.193(*)
	Sig. (2-tailed)	0.062	.	0.562	0.012
	N	170	170	170	170
visual	Pearson Correlation	.164(*)	-0.045	1	0.086
	Sig. (2-tailed)	0.032	0.562	.	0.266
	N	170	170	170	170
sequential	Pearson Correlation	0.044	.193(*)	0.086	1
	Sig. (2-tailed)	0.572	0.012	0.266	.
	N	170	170	170	170

* Correlation is significant at the 0.05 level (2-tailed).

7. 2.3 Determining the sample size

The general equation for sample size in all population both large and small is given by Louis M. Red and Richard A. Parker (1997).

$$n = \frac{(Z_\alpha)^2\,[p(1-p)](N)}{(Z_\alpha)^2[p(1-p)] + (N-1).(Cp)^2}$$

Where Cp = confidence Interval in terms of preparation

Z_α = Z score for various levels of confidence (α)

p = the true proportion

N= sample size of population

To proceed with the calculation of the sample sizes (n), the value of Z_α, Cp and p must be established. Z_α, set at 1.96 for the 95 percent level of confidence or 2.575 for 99 percent. The confidence interval Cp is typically set not to exceed 10 percent and is more frequently set in the 3 to 5 percent range, depending on the

specific degree of accuracy to which the finding must conform. The true proportion (p) is unknown and it can be estimated by the proportion that would result in the highest sample size at p =.5

Thus, by applying equation (1) to this study, and we have the population of Economics and Business Administration Faculty (N= 7000), the sample size needed will be

$$n = \frac{(1.96)^2 \cdot (.25) \cdot (7000)}{(1.96)^2 \cdot (.25) + (7000 - 1) \cdot (.05)^2}$$

n = 364

And for the population of the Arts and Humanities Faculty (N= 10000), the sample size needed will be

$$n = \frac{(1.96)^2 \cdot (.25) \cdot (10000)}{(1.96)^2 \cdot (.25) + (10000 - 1) \cdot (.05)^2}$$

n = 370

7.2.4 Results and Discussion Reliability of ILS questionnaire

7.2.4.1 Internal Consistency Reliability

The Cronbach's alpha coefficient was calculated for each of the four scales of the ILS based on the sample of 532 students of the Arts and Humanities Faculty, the sample of 492 students of the Economics and Business Administration Faculty and the sample of 1024 students of the Economics and Business Administration Faculty and the Arts and Humanities Faculty (see Table 7.14).

Table 7.14: Cronbach alpha values for Arts and Humanities Faculty and Economics and Business Administration Faculty

Scale	**A-R**	**S-N**	**V-V**	**S-G**	**N**
Cronbach Alpha Value	.496	.537	.585	.403	N= 532 (Arts and Humanities Faculty)
	.435	.519	.581	.405	N= 492 (Economics and Business Administration Faculty)
	.467	.533	.582	.404	N=1024 (Arts and Humanities Faculty and Economics and Business Administration Faculty)

7.2.4.2 Correlation Analysis between Scale Scores on the ILS

The results of correlational analyes are shown in Table 7.15. The correlations in Table 7.15 present the correlations; asterisks (*) indicate whether a particular Correlation is significant at the .05 level (*) or the .01 level (**), *P* values are associated with the significance tests for these correlations and sample size (1024). Note that the information in the upper-right triangle of the matrix is redundant with the information in the lower-left triangle of the matrix and can be ignored. A correlation coefficient would not be significant unless *P* value is less than .05 or .01. Pearson's correlation coefficients, given in Table 7.15, show that many dependencies between styles, in some cases also between styles belonging to the same ILS dimension (active/reflective 1 and sensing/ intuitive 1) are found. *P* values represent the probability of obtaining the same correlation coefficients in the case of no correlation (null hypothesis). The smaller the p values, the greater the significance According to the threshold .05, the correlation coefficients are shown to be significant in all cases except the two belonging to all dimension. Direct inter-scale correlation was considered. In order to assess separate qualities, the inter-scale correlation should be minimal. Table 7.15 shows Pearson's correlation coefficients computed between scores on the ILS scales. The eight scales had negligible inter-scale correlation; for example, a weak correlation (r = 0.24) was observed between the sensing and sequential scores. Van Zwanenberg et al. (2000) also found the overlap between Sensing and Sequential scales, as well as the inter-scale correlation

between these two. For the Pearson's correlation coefficients computed between scores on the other ILS scales see Table 7.15

Table 7.15: The Pearson Correlations among learning styles Scales

		Act	Ref	Sen	Int	Vis	Ver	Seq	Glo
Act	Pearson Correlation	1	-1.000**	.047	-.048	.157**	-.158**	.113**	-.114**
	Sig. (2-tailed)		.000	.134	.126	.000	.000	.000	.000
	N	1024	1024	1024	1024	1024	1024	1024	1024
Ref	Pearson Correlation	-1.000**	1	-.047	.048	-.157**	.158**	-.113**	.115**
	Sig. (2-tailed)	.000		.132	.123	.000	.000	.000	.000
	N	1024	1024	1024	1024	1024	1024	1024	1024
Sen	Pearson Correlation	.047	-.047	1	-1.000**	.064*	-.064*	.239**	-.237**
	Sig. (2-tailed)	.134	.132		.000	.039	.040	.000	.000
	N	1024	1024	1024	1024	1024	1024	1024	1024
Int	Pearson Correlation	-.048	.048	-1.000**	1	-.065*	.065*	-.239**	.237**
	Sig. (2-tailed)	.126	.123	.000		.039	.039	.000	.000
	N	1024	1024	1024	1024	1024	1024	1024	1024
Vis	Pearson Correlation	.157**	-.157**	.064*	-.065*	1	-1.000**	.046	-.046
	Sig. (2-tailed)	.000	.000	.039	.039		.000	.145	.139
	N	1024	1024	1024	1024	1024	1024	1024	1024
Ver	Pearson Correlation	-.158**	.158**	-.064*	.065*	-1.000**	1	-.046	.047
	Sig. (2-tailed)	.000	.000	.040	.039	.000		.140	.134
	N	1024	1024	1024	1024	1024	1024	1024	1024
Seq	Pearson Correlation	.113**	-.113**	.239**	-.239**	.046	-.046	1	-.999**
	Sig. (2-tailed)	.000	.000	.000	.000	.145	.140		.000
	N	1024	1024	1024	1024	1024	1024	1024	1024
Glo	Pearson Correlation	-.114**	.115**	-.237**	.237**	-.046	.047	-.999**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.139	.134	.000	
	N	1024	1024	1024	1024	1024	1024	1024	1024

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

7.2.5.2 Factor Analysis

Exploratory factor analysis was conducted. The first step in the exploratory factor analysis was to estimate the number of factors in the ILS using a "scree plot" of the eigenvalues, which is presented in Figure 7.2. In the scree plot, the Eigenvalues are plotted in order from the largest to the smallest value. The Kaiser-Gutman criterion (eigenvalue > 1) indicates that there are more than four factors in the ILS (Zywno, 2003; Litzinger et al., 2005).

Factor analysis was performed. The number of factors extracted using Kaiser's criterion (eigenvalues greater than 1.0) was 16, accounting for 54 % of the total variance. Using the "scree plot" test, in which components are ignored beyond the place where the smooth decrease of eigenvalues appears to level off to the right of the plot, the number of extracted factors was equal to 6, accounting for 28% of the

total variance. The corresponding scree plot is shown in Figure 7.2. The first method (Kaiser Criterion) sometimes retains too many factors, while the second (scree test) sometimes retains too few. However, both do quite well under normal conditions, that is, when there are relatively few factors and many cases.

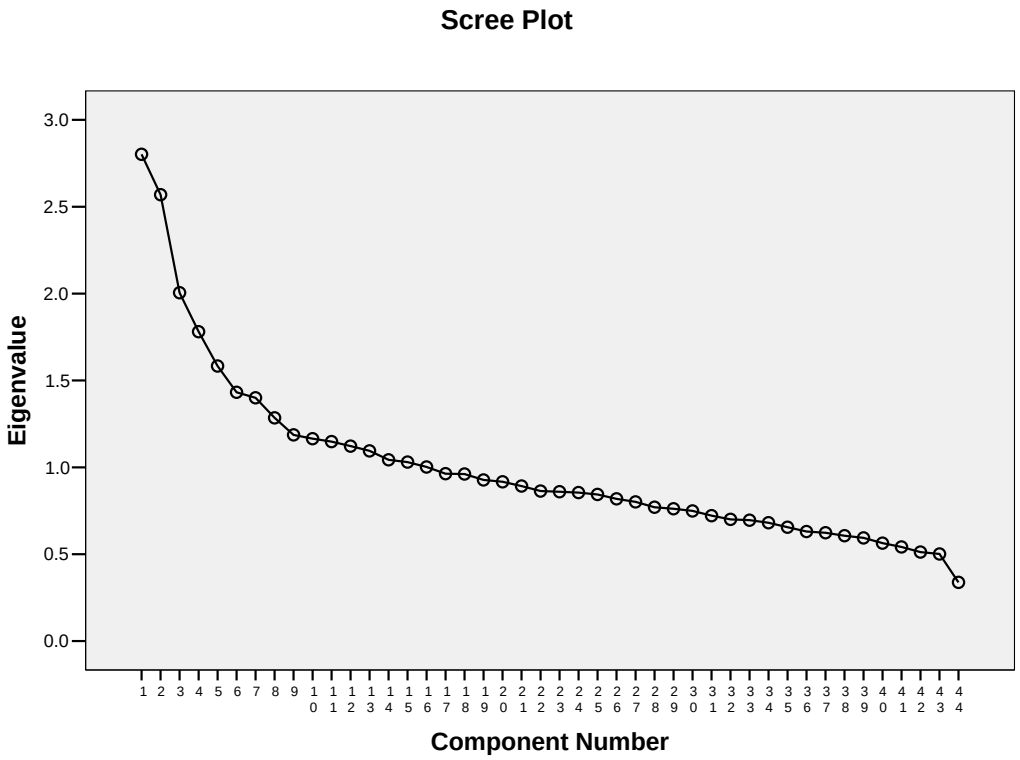

Figure 7.2: Scree Plot for Factor Analysis on ILS Scores (n =1024)

A series of factor analyses were performed with four to eight factors. For each of the analyses, the Visual-Verbal scale maintained consistent structure, with all ten items consistently loading on a single factor. The other scales were found to relate to more than one factor. The results from the eight factor solution are summarised in Table 7.16. A review of the items related to each of the factors was done to establish the nature of the factors, which are summarised in Table 7.16. The Sequential-Global scale consists of four factors, preference for sequential over random or holistic thinking and emphasis on details over the "big picture." Also, Active-Reflective Preference consists of four factors related to action or reflection as an initial approach, being outgoing or reserved in social situations and favourable or

unfavourable attitude towards group work. Finally, the Sensing – Intuitive Preference has three factors for concrete information or abstraction.

The factor analysis provides evidence of construct validity for the ILS. The strongest evidence is for the Visual-Verbal and Sensing/Intuitive scales, for which all items load on a three factor and the Cronbach alpha is high greater than .5(see Table 7.14). For the Active-Reflective and Sequential-Global scales the identified factors appear to be appropriate for the scales. However, the values of the Cronbach alphas for these two scales were relatively weak. All scales indicate that their factors are Moderate association correlated because Correlation coefficients values between .30 and .49. The results of factors analysis are accurate because the Cronbach alpha value is high. The correlation between the four scales should be Moderate association.

Table 7.16: Factors in the eight factor solution

Scale	#F	Items
Active/Reflective	1	25,33
	3	29,37,13,21,9,41
	2	17,5
	6	1
Sensing/Intuitive	2	30,22,2,14,26,18,34
	4	10,6,38
	1	42
Visual/Verbal	1	7,11,15,23,27,31,43,3,19,35
	2	39
Sequential/Global	1	12,24
	2	20,36,8,44,40
	3	32,16
	6	28,4

7. 3 Applying learning styles to Arabic speaking groups

This section compares responses to two Arabic speaking groups in different faculties at the King Abdul-Aziz University in Saudi Arabia: The Arts and Humanities Faculty and the Economics and Administration Faculty. The results are mostly consistent between the two samples. Further analysis indicates that the Arabic version of the Felder-Soloman Index of Learning Styles (ILS) is an appropriate

psychometric instrument to identify learning styles in Arabic speaking communities. Also, this section covers a comparison of percentage of learners with a dominant Style against data about other studies and classifying the preferences of learners.

7. 3.1 Comparison of Felder's Learning Styles Scores between Arts and Humanities Faculty and Economics and Business Administration Faculty

Based on validation of Felder-Soloman's Index of Leaning Styles that more students are active, sensing, sequential and visual than reflective, intuitive, verbal and global. Table 7.17 of the pilot study, also based on validation of Felder-Soloman's Index of Leaning Styles Arabic version, shows that more students are active, sensing, sequential and visual than reflective, intuitive, verbal and global. The default learning style is active/sensing/sequential/visual in Economics and Business Administration Faculty, but in Arts and Humanities Faculty more students are active, intuitive, sequential and visual than reflective, sensing, verbal and global (Van Zwanenberg, et al., 2000; Zywno,2003; Zlatko,2005). See Table 7.18.

Table 7.17: Percentage preferences per scale (pilot study)

Processing	Active	68%	Reflective	23%	N
Perception	Sensing	53%	Intuitive	47%	
Input	Visual	85.%	Verbal	15%	34
Understanding	Sequential	71.%	Global	29%	

The comparison of the Arts and Humanities and Economics and Business Administration students' results from the ILS survey are shown in Table 7.18 and Figures 7.3. Based on learning styles frequencies, we defined the dominant Arts and Humanities student as active, intuitive, visual and sequential, while the dominant Economics and Business Administration student is active, sensing, visual and sequential. In other words, students of Arts and Humanities are different from Economics and Business Administration students in the way they perceive information (sensing/intuitive). However, Arts and Humanities and Economics and

Business Administration students prefer to input, process and understand the information in the same way (visually, actively and sequentially).

Table 7.18: Comparison of student's learning styles frequencies

Faculty	Active	Sensing	Visual	Sequential
Arts and Humanities Faculty	65%	47%	87%	62%
Economics and Administration Faculty	61%	56%	89%	62%

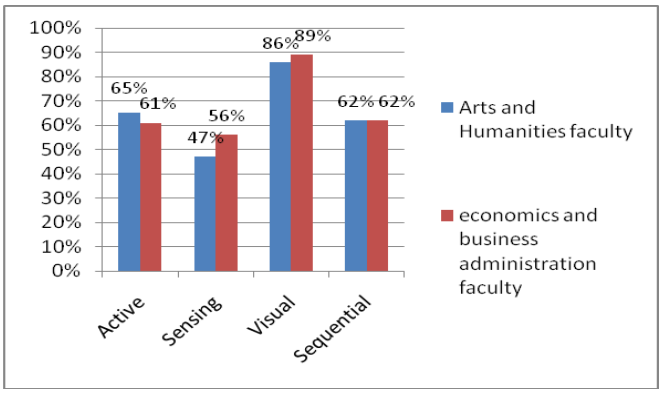

Figure: 7.3: Comparison of Felder's learning styles scores between Arts and Humanities and Economics and Administration faculties

Comparison of Felder's learning styles scores is made between the Arts and Humanities Faculty and the Economics and Business Administration Faculty for each mean difference. The P-value indicates the likelihood of obtaining a difference as large as that observed if it occurred simply from randomness in the data. A low P-value implies that we would probably not observe such a large difference from purely random data and the difference must be the result of some systematic effect. By convention, we usually label any difference with a P-value of 0.05 or less as meaningful, that is, statistically significant. Both the mean scores for the Perception (sensing/intuitive) dimensions show high F-ratio values, which are statistically significant. The P-values for these scores differences are less than 0.00 (positive but less than 0.0005%). These are very low and well below the conventional cut-off point of 0.05, so the differences are statistically significant and we can state with a

high level of confidence that students' scores of the Arts and Humanities Faculty are different from the scores of the Economics and Administration Faculty on one dimension. In cases of processing (active/reflective), understanding (sequential/global) and inputting (visual/verbal) dimensions, the P-values were very high (above 0.05), so neither difference was statistically significant (see table 7.19).

Table 7.19: Comparison of Felder's learning styles scores between Arts and Humanities Faculty and Economics and Administration Faculty

Dimension	Mean score(econ)	Mean score(Arts)	Mean difference	F-ratio	P-value
Active score	6.04	6.2	-0.16	1.639	.20
Reflective score	4.9	4.8	0.1	1.674	.19
Sensing score	5.8	5.3	0.5	13.4**	.000
Intuitive score	5.2	5.7	-0.5	13.7**	.000
Visual score	7.9	7.8	0.1	.075	0.78
Verbal score	3.1	3.2	-0.1	.054	0.82
Sequential score	6.2	5.9	0.3	1.97	.16
Global score	4.8	5.0	-0.2	1.89	.169

** F-ratio is significant at the 0.01 level.

To test the hypothesis that the results of Felder-Solomon ILS scores of the Arts and Humanities students correlate with the scores of the Economics and Administration students, between learning styles of the Arts and Humanities students and the learning styles of the Economics and Administration students, we have calculated the Pearson's correlation coefficients between the students' evaluation scores and the different dimensions of the Felder-Solomon ILS and presented them in Table 7.20. The figure between the brackets shows P-value, i.e. the level of significance. The P-value indicates the likelihood of obtaining a correlation coefficient as large as that observed if it occurred simply from randomness in the data. A low P-value implies that we would probably not observe such a large correlation coefficient from purely random data and the coefficient must be the result of a linear relationship between observed series.

Table 7.20: Correlation between learning styles of Arts and Humanities students and learning styles of the Economics and Administration students

	ACT	SEN	VIS	SEQ
Learning styles of Arts and Humanities students match learning styles of the Economics and Administration students	-.034 (.451)	.042 (.357)	.103* (.022)	.029 (.524)

* Significant at the 0.05 level.
** Significant at the 0.01 level.

For the first variable (how close learning styles of the Arts and Humanities students match the learning styles of the Economics and Administration students) all the correlation coefficients have the expected sign. Since the Arts and Humanities students are visual learners, we would expect a positive correlation between the visual scores of the Economics and Administration students as regards how close their learning style matches the Arts and Humanities students' learning style. On the other hand, for active, sensing and sequential scores, we would expect a negative correlation because the Arts and Humanities students learn is the opposite way (reflective, intuitive and global). However, only the correlation coefficients for visual scores show some statistical significance (22% and the level of relationship is quite low, about 0. 103).

7.3.2 A Comparison of Percentage of Learners with a Dominant Style against Data about other Studies

The Felder-Solomon learning styles frequencies concerns female students in King Abdul-Aziz University in Saudi Arabia, representing the Arts and Humanities and Economics and Administration faculties. Students are listed in Table 7.21 along with the results of a number of published studies relevant to this study. In all these studies the same learning style model and instrument have been used in the various departments. The four columns in Table 7.21 labelled Active, Sensing, Visual and Sequential show the percent of students who are active, sensor, visual and sequential learner.

Table 7.21 supports convergent validity of the ILS scores, as female students in King Abdul-Aziz University share, at different times and in different places, many

characteristics hypothesised by the model based on comparative data. It appears that the Arts and Humanities students are less sensing (the lowest sensing frequency of 47% only), but more visual than participants from other academic universities (the highest visual frequency of 87%). The result indicates that approximately 87% of Arts and Humanities students prefer the visual mode in comparison with only 14% of students who prefer the verbal mode. Also, based on comparative data, it appears that Economics and Administration students are less sensing (the lowest sensing frequency of 56% only), but more visual than participants from other academic universities (the highest visual frequency of 89%). The result indicates that approximately 89% of Economics and Administration students prefer the visual mode in comparison with only 11% of students who prefer the verbal mode.

Table 7.21 shows a percentage comparison of learners with a dominant style against data related to other studies using ILS in various countries reported in Felder and Spurlin (2005) and Zualkernan (2005). Table 7.21 shows that the learning styles of students in King Abdul-Aziz University in Saudi Arabia (Economics and Administration Faculty) are in similar ranges to those from comparable universities in the US, Ryerson University, U. Belo Horizonte, University of Puerto-Rico, U. of Sao Paulo, University Kingston, the United Arab Emirates (UMD) and the American University of Sharjah (AUS) (similar in terms of sensing, visual and sequential). However, the learning styles of students in King Abdul-Aziz University in Saudi Arabia (Economics and Administration Faculty) are not in similar ranges to those from comparable universities in the US, University of Puerto-Rico and United Arab Emirates (there are some discrepancies in the active only). Moreover, the learning styles of students in King Abdul-Aziz University in Saudi Arabia (Arts and Humanities Faculty) are in similar ranges to those from comparable universities in the US, Ryerson University, U. Belo Horizonte, University of Puerto-Rico ,U. of Sao Paulo, University Kingston, the United Arab Emirates (UMD) and the American University of Sharjah (AUS) (similar in terms of the visual and sequential). However, the learning styles of students in King Abdul-Aziz University in Saudi Arabia (Arts and Humanities Faculty) are not in similar ranges to those from comparable Universities in the US, University of Puerto-Rico and the United Arab

Emirates (there are some discrepancies in the active only), as well as the US, Ryerson University, U. Belo Horizonte, University of Puerto-Rico, U. of Sao Paulo, University Kingston, the United Arab Emirates (UMD) and the American University of Sharjah (AUS) (there are some discrepancies in the sensing only).

Table 7.21 shows that the learning styles of students in the Arts and Humanities Faculty and the Economics and Administration Faculty are in similar ranges to those from comparable universities in the US, Ryerson University, U. Belo Horizonte, University of Puerto-Rico, U. of Sao Paulo, University Kingston, United Arab Emirates (UMD) and the American University of Sharjah (AUS) (similar in terms of sensing, visual and sequential). However, the learning styles of students in the Arts and Humanities Faculty and Economics and Administration Faculty in King Abdul-Aziz University are not in similar ranges to those from comparable Universities in the US, University of Puerto-Rico and the United Arab Emirates (there are some discrepancies in the active only).

Table: 7.21: Learning style preferences across countries

Country	**Active**	**Sensing**	**Visual**	**Sequential**
US, Ryerson University	53%	66%	86%	72%
Brazil, U. Belo Horizonte	65%	81%	79%	67%
US, University of Puerto-Rico	47%	61%	82%	67%
Brazil, U. of Sao Paulo	57%	68%	80%	51%
Jamaica, University Kingston	55%	60%	70%	55%
AUS	51%	64%	79%	71%
UMD	46%	65%	90%	70%
King Abdul-Aziz University in Saudi Arabia(Arts and Humanities Faculty)	65%	47%	87%	62%
King Abdul-Aziz University in Saudi Arabia(Economics and Business Administration Faculty)	61%	56%	89%	62%
King Abdul-Aziz University in Saudi Arabia(Arts and Humanities Faculty and Economics and Business Administration)	63%	52%	87%	62%

7.3.3 Classifying the Preferences of Learners

Tables 7.22 and 7.23 show a more detailed description, classifying the preferences of learners in moderated (values from 5 to 7), strong (values from 9 to 11 in the ILS) and balanced (values from +3 to -3 in the ILS).

Table 7.22: Fraction of responses in three response categories for ILS version Arabic (pilot study)

	Active/ Reflective	Sensing/ Intuitive	Visual/ verbal	Sequential/ Global	N
Mild	65%	62%	35%	56%	34
Moderate	32%	32%	41%	32%	
Strong	3%	6%	24%	12%	

Table 7.23 shows a more detailed description, classifying the preferences of learners in strong/moderated (values from 5 to 11 in the ILS) and balanced (values from +3 to -3 in the ILS). Looking at the overview of similar studies given by Felder and Spurlin (2005), our results are mainly in agreement with the results of these studies, but not mainly in agreement as regards preferences of learners in strong/moderated sensing (San Jose State University, Arizona State University, Graduate Students in Social Work and Brazilian Science). Also, the results are not mainly in agreement with the results of these studies in preferences of learners in mild sensing/ intuitive (Ryerson University, Engineering student 2002 cohort, San Jose State University, Mechanical Engineering students, San Jose State University, Arizona State University, Graduate Students in Social Work and Brazilian Science).

Table 7.23: Strengths of preferences (Felder and Spurlin, 2005)

	Act-Ref			Sen-Int			Vis-Vrb			Seq-Glo		
	Mod Str Act	Mild	Mod Str Ref	Mod Str Sen	Mild	Mod Str Int	Mod Str Vis	Mild	Mod Str Vrb	Mod Str Seq	Mild	Mod Str Glo
Ryerson University, Engineering student, 2000 cohort: N=87	27%	58%	15%	38%	52%	11%	69%	28%	3%	34%	52%	15%
Ryerson University, Engineering student, 2001 cohort: N=119	32%	50%	18%	38%	50%	12%	64%	32%	5%	21%	63%	16%
Ryerson University, Engineering student, 2002 cohort: N=132	30%	55%	15%	36%	49%	15%	62%	35%	3%	24%	62%	14%
San Jose State University, Materials Engineering Students, N=261	-	60%	-	-	52%	-	-	36%	-	-	58%	-
San Jose State University, Mechanical Engineering Students, N=196	-	55%	-	-	47%	-	-	36%	-	-	62%	-
San Jose State University, Freshman Engineering Students, N=693	-	61%	-	-	52%	-	-	45%	-	-	64%	-
San Jose State University, Engineering Students, N=183	24%	61%	15%	43%	46%	11%	61%	34%	5%	31%	58%	11%
Arizona State University, Graduate Students in social work	31%	54%	15%	48%	38%	14%	38%	45%	17%	20%	69%	11%
Brazilian Science students, N=214	25%	69%	6%	49%	46%	5%	46%	48%	6%	29%	64%	7%
Brazilian Humanities students, N=235	19%	65%	16%	33%	51%	16%	10%	61%	29%	27%	57%	15%
King Abdul-Aziz University in Saudi Arabia(Arts and Humanities faculty),N =532	27%	63%	10%	17%	62%	21%	60%	37%	3%	22%	68%	10%
King Abdul-Aziz University in Saudi Arabia(economics and administration faculty) N= 492	24%	62%	11%	23%	63%	15%	60%	37%	3%	23%	63%	15%
King Abdul-Aziz University in Saudi Arabia(Arts and Humanities faculty and economics and business administration) N =1024	26%	64%	10%	20%	63%	18%	60%	37%	3%	24%	66%	10%

7. 4 Results and Discussion of Trial Test

Participants consisted of 80 students from the Arts and Humanities Faculty, organised into three different groups (different groups, but the same chapter):

1. Group (A) consisting of 22 students were given the chapter covering the T-Test to work through in TASAM with no professor explanation of the chapter (T-Test).
2. Group (B) consisted of 18 students who were given the T-Test chapter to work through in the TASAM system, but also had teacher explanation of the chapter (T-Test).
3. Group (C) consisted of 40 students that were given teacher explanation of the T-Test chapter (i.e. without using the TASAM adaptive system).

7. 4.1 Comparing the Three Groups (Group A, Group B and Group C)

Significant differences between the three groups can be determined using the statistical technique one way analysis of variance (ANOVA). This will show weather the differences between the scores of exam among the three groups were significant and will determine if the impact on learning performance when materials were matched with learning styles. Table 7.25 shows the main results of ANOVA method. The hypotheses state that there are at least one significant difference between the three groups:

H0: group (B) will learn significantly better than group (A).

H1: group (A) will learn significantly better than group (C).

H2: group (B) will learn significantly better than group (C).

The descriptive results of the groups are shown in table 7.24 which shows the mean and standard deviation for each group. In addition, table 7.25 shows that the ANOVA F test indicates that there exist significant differences between the scores of exam for at least one of the three groups ($F(2, 77) = 4.247$, $P = .018$).

Table 7.24: Dependent Variable: score (Descriptive Statistics)

Three_groups	Mean	Std. Deviation	N
group(A)	6.6364	2.59203	22
group(B)	6.4444	1.82216	18
group(C)	4.9500	2.63069	40
Total	5.7500	2.56313	80

Table 7.25: Tests of between – subject effects

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	51.565(a)	2	25.782	4.247	.018	.099
Intercept	2580.032	1	2580.032	425.005	.000	.847
Three_ groups	51.565	2	25.782	4.247	.018	.099
Error	467.435	77	6.071			
Total	3164.000	80				
Corrected Total	519.000	79				

R Squared = .099 (Adjusted R Squared = .076)

The mean values for the scores group (A) and the mean values of the scores of group (B) are listed in Table 7.24, and it appears that the mean for the scores of group (A) is higher than the mean scores of group (B) (6.636 > 6.444). In Table 7.26 *P*=0. 81 > 0.05 indicates that there are no significant differences between the scores among the two groups.

The mean values for the scores of group (A) and the mean values of the scores of group (C) are listed in Table 7.24, and it appears that the mean for the scores of group (A) is higher than the mean scores of group (C) (6.64> 4.95). In Table 7.26 *P*=0.012 < 0.05 indicates that students of group (A) will learn significantly better than students of group (C).

The mean values for the scores of group (B) and the mean values of the scores of group (C) are listed in Table 7.24, and it appears that the mean for the scores of group (B) are higher than the mean scores of group (C) (6.44> 4.95). In Table 7.26 *P* =0.036 < 0.05 this indicated that students of group (B) will learn significantly better than students of group (C).

Table 7.26: Post Hoc Tests

The results of post hoc comparisons are shown in table 7.30 using LSD test.

Dependent Variable: score

LSD

(I) type_group	(J) type_group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
group (A)	group (B)	.1919	.78307	.807	-1.3674	1.7512
	group (C)	1.6864*	.65399	.012	.3841	2.9886
group (B)	group (A)	-.1919	.78307	.807	-1.7512	1.3674
	group (C)	1.4944*	.69930	.036	.1020	2.8869
group (C)	group (A)	-1.6864*	.65399	.012	-2.9886	-.3841
	group (B)	-1.4944*	.69930	.036	-2.8869	-.1020

Based on observed means.

*. The mean difference is significant at the .05 level.

7. 5 Results and Discussion of Initial Evaluation

Section 7.5 covers the initial evaluation and assessment of the adaptive learning system by students and teacher.

7. 5.1 Teachers' survey

A questionnaire evaluating teachers was answered by four teachers, who used the TASAM teaching environment (table 7.27). It shows that all teachers have a background using the computer and the Internet. Table 7.27 also shows that most teachers enter and browse the site related to their study from the university (25 percent browse the site from home). As Table 7.27 reveals, 75 percent of teachers thought the subject related to their study was interesting and clear and 50 percent of teachers thought the examples were interesting and clear. One hundred percent of teachers strongly agreed that the subject presented this way makes it easy to understand. One hundred percent of teachers strongly agreed that using technology in education makes it easier. Table 7.27 provides more details from the teachers' survey.

Table 7.27: Questionnaire of evaluation Teacher

	option			
Questions	**Percent**	**Percent**	**Percent**	**Percent**
Q1) DO you have a background on using the computer?	I know so much	sort of	a little	no idea
	100%			
Q2) Do you have a background on using the internet?	100%			
Q3) Where can you enter and brows the site related to your study? www.adaptivelearningstyle.com?	Home	university	Home & university	other
	25%	50%	25%	0%
Q4) Is entering and browsing the site related to your study? www.adaptivelearningstyle.com	So easy	Easy	Kind of easy	Not easy
	50%	50%		
Q5) Was showing the subject related to your study?	75%	25%		
Q6) Showing the subject related to your study was interesting and clear?	Interesting and clear	Interesting and not clear	Clear and not Interesting	not Clear and not Interesting
	75%	25%		
Q7) The examples were?	50%	50%		
Q8) Showing the subject this way makes it easy to understand it?	Strongly agree	agree	Don't agree much	Disagree
	100%			
Q9) Do you think using technology in education makes it easier?	100%			

7. 5.2 Most representative electronic media teachers prefer in their teaching

In figure 7.4 most teachers (17 percent) would like the subject to be shown as graphics and pictures, examples, exercises and self-test; 13 percent would like a slideshow; and 9 percent would like a video and text.

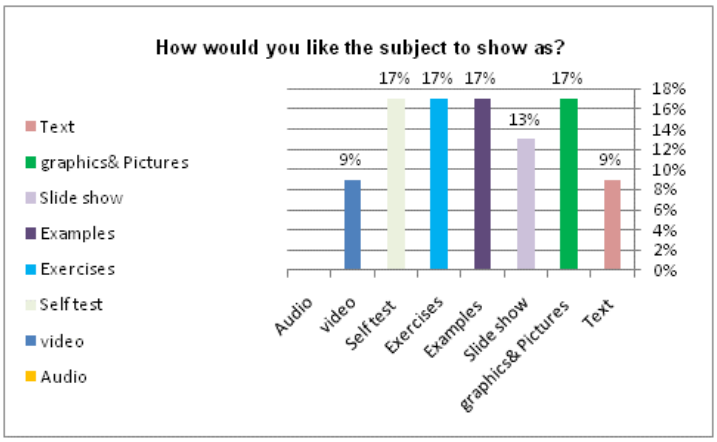

Figure 7.4: The most representative media formats if teachers choose subject materials

In figure 7.5, most teachers (24 percent) prefer as the navigation tool a print button and forward/back button when browsing the subject materials. Eighteen percent prefer a jump button, home page button and tree of course index.

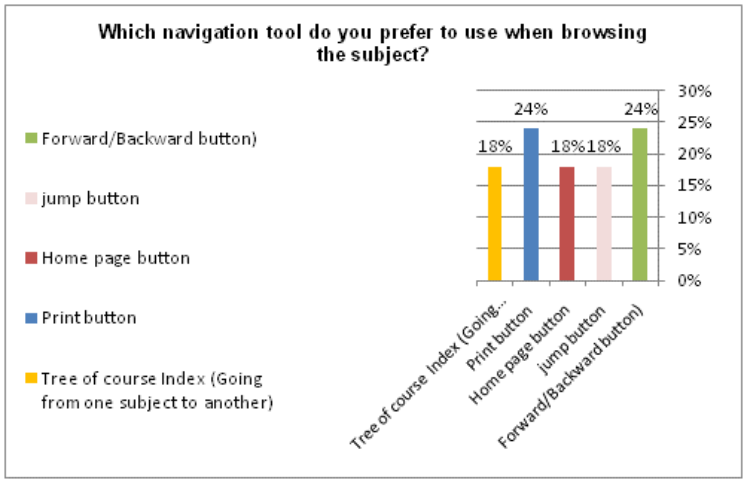

Figure 7.5: The three most representative navigation tools if teachers browsing subject materials.

In figure 7.6, 29 percent of teachers prefer a phone to communicate with students; twenty-one percent prefer email and a forum; and 14 percent prefer personal interview and chat.

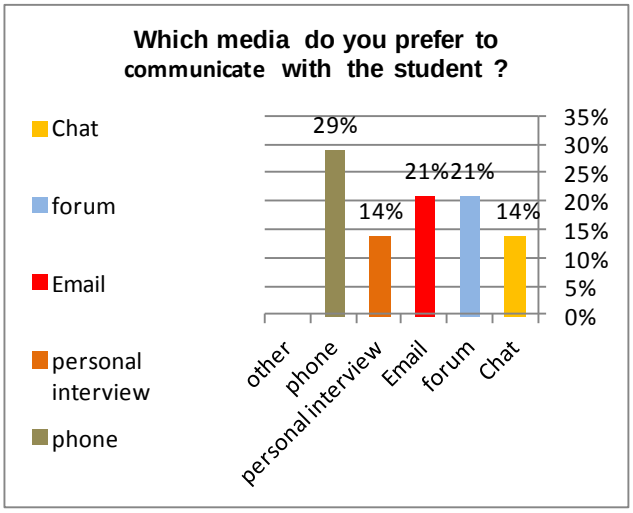

Figure 7.6: The most representative media format if teachers communicate with the student

7. 5.3 Students' survey

The evaluation questionnaire was answered by 32 students, who used the TASAM teaching environment. The table shows that 34% of students have a background using computers and 38 % have a background using the Internet. In general, Table 7.28 shows that most students enter and browse the site related to their study from home (88 percent browse the site from home). As the Table 7.28 reveals, students shown the subject related to their study found it interesting and clear. The examples were interesting and clear (78 percent shown the subject related to their study found it interesting and clear and 69 percent shown the examples found it interesting and clear). Fifty-three percent of students strongly agree that when presented in this way the subject is easy to understand. Sixty-six percent of students strongly agree that using technology in education makes it easier (see table 7.28). For more details about the students' survey see Table 7.28.

Table 7.28: Students' Evaluation Questionnaire

	option			
Questions	**Percent**	**Percent**	**Percent**	**Percent**
Q1) DO you have a background on using the computer?	I know so much	sort of	a little	no idea
	34%	63%	3%	0%
Q2) Do you have a background on using the internet?	38%	59%	3%	0%
Q3) Where can you enter and brows the site related to your study? www.adaptivelearningstyle.com?	Home	university	Home & university	other
	88%	3%	9%	0%
Q4) Is entering and browsing the site related to your study? www.adaptivelearningstyle.com	So easy	Easy	Kind of easy	Not easy
	50%	25%	25%	0%
Q5) Was showing the subject related to your study?	53%	31%	16%	0%
Q6) Showing the subject related to your study was interesting and clear?	Interesting and clear	Interesting and not clear	Clear and not Interesting	not Clear and not Interesting
	78%	16%	6%	0%
Q7) The examples were?	69%	19%	6%	3%
Q8) Showing the subject this way makes it easy to understand it?	Strongly agree	agree	Don't agree much	Disagree
	53%	38%	6%	3%
Q9) Do you think using technology in education makes it easier?	66%	22%	13%	0%

7. 5.4 Most Representative Electronic Media Students Prefer in their Study

In figure 7.7 most students (27 percent) would like the subject shown as graphics and pictures. In comparison, twenty-three percent of students would like the subject shown as examples. Seventeen percent would prefer exercises, and 5 percent would like a self-test. Fourteen percent want to be shown a slideshow and 3 percent show subject as video and text.

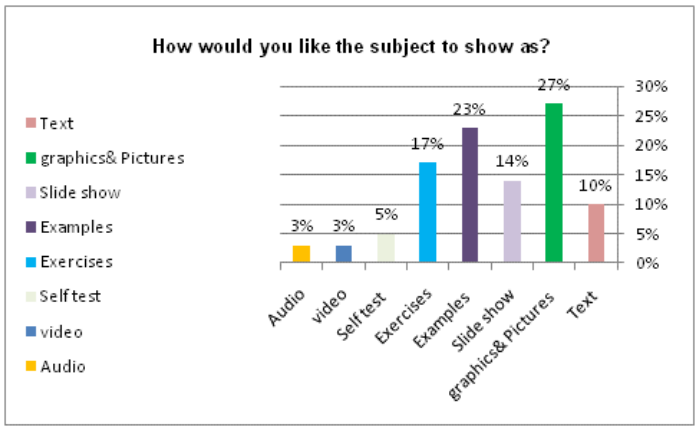

Figure 7.7: The most representative media formats if students chose subject materials.

In figure 7.8 most students (49%) prefer the navigation tool as a forward/back button. Twenty-nine percent prefer a print button; and 9 percent prefer a jump button, home page button and tree of course index

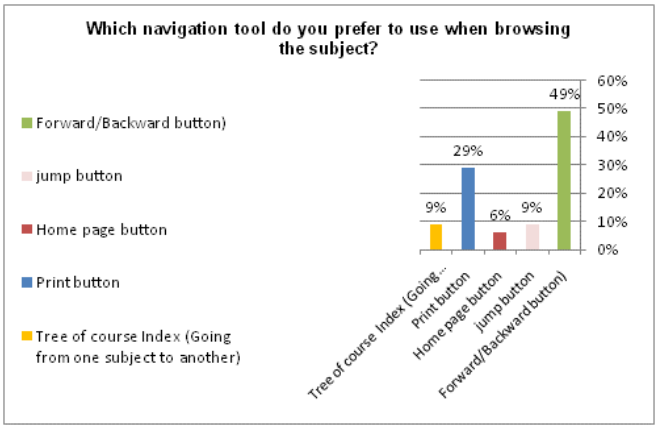

Figure 7.8: The three most representative navigation tool if students browse subject materials

In figure 7.9 most students prefer a phone to communicate with a teacher (51%); 21 percent prefer chat; 21 percent prefer email; 2 percent prefer a forum; and 9 percent prefer personal interview.

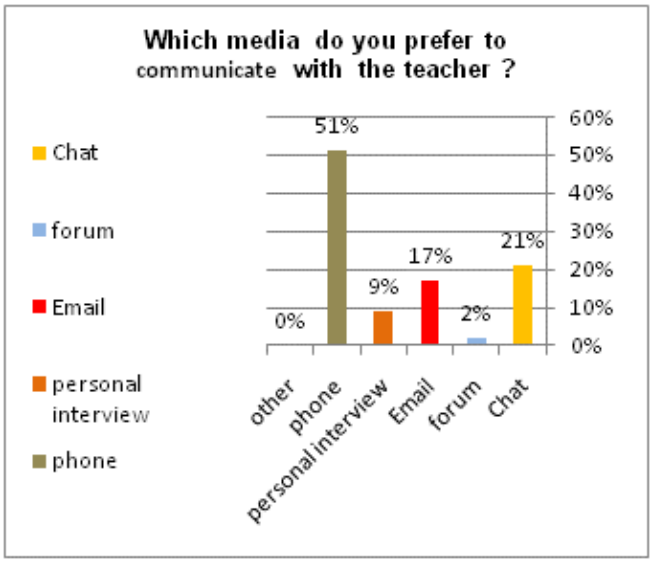

Figure 7.9: The most representative media format if students communicate with the teacher

7. 5.5 Students and Teacher Feedback Survey in the Trial Test

Overall, teachers seemed to have enjoyed using the TASAM system and there seemed to have been a positive impact on learning performance. The feedback from the Students Survey suggests that the students felt comfortable carrying out the learning activities proposed in the teaching units even though they would have preferred closer materials and tools. The students felt that the system was useful and interesting, but the idea was new and it made education easy. The students carried out the learning activities with the motivation of a good final mark. Overall, students seemed to have enjoyed using the TASAM system and there seemed to have been a positive impact on learning performance.

7. 6 Results and Discussion of Final Test System (TASAM) – First Semester

Participants consisted of 53 students from the Arts and Humanities Faculty, organised into two different groups:

1. Group (D) consisted of 28 students, and four different cases.
    - Group(D), Case 1: students using the TASAM system with no professor explanation of the chapter (Measures of Variability and Correlation)
    - Group(D), Case 2: students not using the TASAM system and only using the professor explanation of the chapter (Central tendency)
    - Group (D), Case 3: students using the TASAM system with professor explanation of the chapter (Measures of Variability and Correlation).
    - Group(D), Case 4: students using the TASAM system with no professor explanation of the chapter (Correlation)
2. Group (E) consisted of 25 students, and three different cases.
    - Group(E), Case 1: students using the TASAM system with no professor explanation of the chapters (Measures of Variability and Central tendency statistics)
    - Group(E), Case 2: students not using the TASAM system and only using the professor explanation of the chapter (Correlation)
    - Group (E), Case 3: students using the TASAM system with professor explanation of the chapters (Measures of Variability and Central tendency statistics).

7. 6.1 Result of a comparison of first case of group (D) with second case of group (D)

In this section Group (D), Case 1 is compared with Group (D), Case 2 (the same group, but different chapters).

H3: Group (D), Case 1 will learn significantly better than Group (D), Case 2

To determine if the students of Group (D), Case 1 will learn significantly better than Group (D), Case 2, the one way repeated measures analysis of variance was used. The main results are presented in Table 7.30.

Table 7.30 shows the results of the ANOVA for within subject variable. This table can be read much the same as for one way independent ANOVA. There is a sum of squares for the within subject effects of the system test, which tells us how much of the total variability is explained by experimental effect – i.e. differences in Group (D), Case 1 and Group (D), Case 2. There is an error term, which is the amount of unexplained variation across the conditions of the repeated measures variable. These sums of squares are converted into mean squares by dividing by the degrees of freedom (Field, 2008).

The *F*-ratio is obtained by dividing the mean squares for experimental effect (12410.012) by error mean squares (31.067). As with between–group ANOVA, this test statistics represents the ratio systematic variance to unsystematic variance. The value of the *F*-ratio (12410.012/31.067 = 399.46) is then compared against a critical value for 1 and 27 degrees of freedom. The significance of *F* is 0, which is significant because it is less than the criterion value of .05. We can, therefore, conclude that there was significance difference in scores of students of Group (D), Case 1 and Group (D), Case 2 (Field, 2008).

The mean values for the scores of students of Group (D), Case 1 and students of Group (D), Case 2 are listed in Table 7.29, and it appears that the mean scores of Group (D), Case 1 are much higher than the mean scores of Group (D), Case 2 (12.46> 11.75). Standard deviation is also listed in Table 7.29. In Table 7.31, *P*=.045 <0.05, which indicates that students of Group (D), Case 1 will learn significantly better than students of Group (D), Case 2.

Table 7.29: Descriptive Statistics

	Mean	Std. Deviation	N
Second _case (group(D))	11.7500	4.22405	28
First _ case (group(D))	12.4643	3.17959	28
Third _ case (group(D))	12.2500	3.26740	28

Table 7.30: Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	12410.012	1	12410.012	399.454	.000	.937
Error	838.821	27	31.067			

Table 7.31: The results of pairwise comparisons

Pairwise Comparisons

Measure: MEASURE_1

(I) test	(J) test	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	-.714*	.340	.045	-1.411	-.017
	3	-.500	.670	.462	-1.875	.875
2	1	.714*	.340	.045	.017	1.411
	3	.214	.496	.669	-.803	1.231
3	1	.500	.670	.462	-.875	1.875
	2	-.214	.496	.669	-1.231	.803

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

7. 6.2 Result of a comparison of first case of group (D) with third case of group (D)

In this section Group (D), Case 1 is compared with Group (D), Case 3 (the same group and chapters).

H4: Group (D), Case 1 will learn significantly better than Group (D), Case 3

The objective is to determine whether the students of Group (D), Case 1 will learn significantly better than Group (D), Case 3. The main results of the one way repeated measures analysis of variance are presented in Table 7.31.

The mean values for the scores of Group (D), Case 1 and Group (D), Case 3 are listed in Table 7.29 and it appears that the mean scores of Group (D), Case 1 are higher than the mean scores of Group (D), Case 3 (12.46 >12.25). The standard deviation is also listed in Table 7.29. In table 7.31, P=.462 > 0.05, this

indicated that there was no significant difference between Group (D), Case 1 and Group (D), Case 3.

7. 6.3 Result of a comparison of first case of group (E) with second case of group (E)

In this section Group (E), Case 1 is compared with Group (E), Case 2 (the same group, but different chapters).

H5: Group (E), Case 1 will learn significantly better than Group (E), Case 2.

To objective is to determine whether he students of Group (E), Case 1 will learn significantly better than Group (E), Case 2). The main results of the one way repeated measures analysis of variance are presented in Table 7.33.

The mean values for the scores of Group (E), Case 1 and Group (E), Case 2 are listed in Table 7.32, and it appears that the mean scores of Group (E), Case 1 are much higher than the mean scores of Group (E), Case 2 (13.76 > 12.9). The standard deviation is also listed in Table 7.32. In table 7.34, P=0.03 < .05; this indicated that students of Group (E), Case 1 will learn significantly better than students of Group (E), Case 2, and there was a very significant difference between Group (E), Case 1 and Group (E), Case 2.

Table: 7.32: Descriptive Statistics

	Mean	Std. Deviation	N
second_case_group(E)	12.9000	2.05649	25
first_case_group(E)	13.7600	1.56205	25
third_case_group(E)	13.2000	1.84278	25

Tables: 7.33: Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	13240.163	1	13240.163	2218.196	.000	.989
Error	143.253	24	5.969			

Table 7.34: The results of pairwise comparisons

Pairwise Comparisons

Measure: MEASURE_1

(I) test	(J) test	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	-.860*	.373	.030	-1.629	-.091
	3	-.300	.396	.456	-1.117	.517
2	1	.860*	.373	.030	.091	1.629
	3	.560	.443	.218	-.354	1.474
3	1	.300	.396	.456	-.517	1.117
	2	-.560	.443	.218	-1.474	.354

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

7.6.4 Result of a comparison of first case of group (E) with third case of group (E)

In this section Group (E), Case 1 is compared with Group (E), Case 3 (the same group and chapters).

H6: Group (E), Case 1 will learn significantly better than Group (E), Case 3.

The objective is to determine whether the students of Group (E), Case 1 will learn significantly better than the students of Group (E), Case 3. The main results of the one way repeated measures analysis of variance are presented in Tables 7.33, and 7.34.

The mean values for the scores of Group (E), Case 1 and Group (E), Case 3 are listed in Table 7.32, and it appears that the mean scores of Group (E), Case 1 are higher than the mean scores of Group (E), Case 3 (13.8 > 13.2). The standard deviation is also listed in Table 7.32. In Table 7.34, P=0.46 > .05 indicates that there was no significant difference between Group (E), Case 1 and Group (E), Case 3.

7. 6.5 Comparing the two different Groups – group (D) and group (E)

In this section Group (D), Case 4 is compared with Group (E), Case 2 (the same chapter, but different groups).

H7: Group (D), Case 4 will learn significantly better than Group (E), Case 2.

An Independent – samples t test was conducted to evaluate the hypothesis that Group (D), Case 4 will learn significantly better than Group (E), Case 2.The mean values for the scores of Group (D), Case 4 and the mean values of the scores of Group (E), Case 2 are listed in Table 7.35, and it appears that the mean for the scores of Group (D), Case 4 are higher than the mean scores of Group (E), Case 2 (14.0.3> 12.7). In table 7.36, P=0. 048 < .0.05 indicates that students of Group (D), Case 4 will learn significantly better than students of Group (E), Case 2.

Table: 7. 35: Descriptive Statistics

Group Statistics

	type_group	N	Mean	Std. Deviation	Std. Error Mean
groups	group(D)_ case4	28	14.0357	1.45251	.27450
	group(E)_ case 2	25	12.9000	2.95141	.59028

Table: 7. 36: Independent Samples T-Test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
groups	Equal variances assumed	9.888	.003	2.030	51	.048	1.27571	.62844	.01407	2.53736
	Equal variances not assumed			1.960	34.086	.058	1.27571	.65099	-.04713	2.59855

7.7 Results and Discussion of final Evaluation Questionnaire in the first semester

Section 7.7 covers Test-Retest reliability of students' first evaluation survey, the result of students'0 first evaluation survey and the final evaluation and assessment of the adaptive learning system by students.

7. 7.1 Test-Retest Reliability of students' first evaluation survey

In estimating test-retest reliability, the same test is administered to the same or similar sample, on more than one occasion. Time elapsing between the measurements is critical. Typically, the longer the time-gap is, the lower the correlation. In the study, the time lapse of one month was dictated by the classroom realities, as described above. Table 7.37 shows a weak correlation between the test and the retest questions of evaluation.

Table 7:37 Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Q1_before & Q1_after	48	-.185	.209
Pair 2	Q2_before & Q2_after	48	-.021	.888
Pair 3	Q3_before & Q3_after	42	-.013	.934
Pair 4	Q4_before & Q4_after	47	-.189	.204
Pair 5	Q5_before & Q5_after	49	.082	.576
Pair 6	Q6_before & Q6_after	48	.048	.745
Pair 7	Q7_before & Q7_after	47	-.121	.416
Pair 8	Q8_before & Q8_after	48	.011	.942
Pair 9	Q9_before & Q9_after	49	-.010	.948
Pair 10	Q10_before & Q10_after	49	.070	.633
Pair 11	Q11_before & Q11_after	49	-.096	.511
Pair 12	Q12_before & Q12_after	47	-.117	.435
Pair 13	Q13_before & Q13_after	49	-.064	.662

Table 7.38: Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Q1_before - Q1_after	.02083	.56454	.08148	-.14309	.18476	.256	47	.799
Pair 2	Q2_before - Q2_after	-.10417	.59213	.08547	-.27610	.06777	-1.219	47	.229
Pair 3	Q3_before - Q3_after	.07143	.60052	.09266	-.11571	.25856	.771	41	.445
Pair 4	Q4_before - Q4_after	.14894	.65868	.09608	-.04446	.34233	1.550	46	.128
Pair 5	Q5_before - Q5_after	.28571	.61237	.08748	.10982	.46161	3.266	48	.002
Pair 6	Q6_before - Q6_after	.10417	.47219	.06815	-.03294	.24128	1.528	47	.133
Pair 7	Q7_before - Q7_after	.14894	.65868	.09608	-.04446	.34233	1.550	46	.128
Pair 8	Q8_before - Q8_after	.06250	.69669	.10056	-.13980	.26480	.622	47	.537
Pair 9	Q9_before - Q9_after	-.36735	.66752	.09536	-.55908	-.17561	-3.852	48	.000
Pair 10	Q10_before - Q10_after	.20408	.57661	.08237	.03846	.36970	2.478	48	.017
Pair 11	Q11_before - Q11_after	-.08163	.64021	.09146	-.26552	.10226	-.893	48	.377
Pair 12	Q12_before - Q12_after	.04255	.46426	.06772	-.09376	.17887	.628	46	.533
Pair 13	Q13_before - Q13_after	.18367	.56544	.08078	.02126	.34609	2.274	48	.027

However, the difference between the means of answers to the fifth, ninth, tenth and thirteen questions were borderline significant (P = 0.002, P=.000, P=.017, P=.027 respectively), and the correlation between the before and after of answers to the fifth, ninth, tenth and thirteen questions were the lowest, at 0. .082,.010, .070, 064 respectively (Table 7.38). Yet, the use of such standard statistical tools may be in fact misleading as a stability predictor of questions evaluation, in such answers for fifth, ninth, tenth and thirteen questions. Homogeneity or heterogeneity of scores affects score reliability since a small change in raw scores leads to large changes in rankings and thus low correlation of the evaluation questions.

7. 7.2 Result of Students' First Evaluation Questionnaire

The evaluation questionnaire was answered by 112 students who learned the material from the site related to learning styles (www.adaptivelearningstyle.com). Table 7.39 shows that most students used the learning style which belongs to them. Table 7.39 reveals that most students thought that the material presented in this manner is easy and clear (82 percent). Table 7.39 shows that students hope the rest of the professors use a similar method of teaching so they can learn in a way that they prefer. It is also easier to teach myself that way. See table 7.39 for more details.

Table 7.39: Students evaluation questionnaire

Questions	Yes	NO
1. I learned the material from the site related to learning styles (www.adaptivelearningstyle.com)	77	23
2. I used the learning style which suits me	62	30
3. I used my friend's learning styles	24	76
4. The material presented in this manner is easy and clear	82	18
5. I hope the rest of the professors use a similar method of teaching so we can learn in a way that we prefer	73	27
6. Information is clear and easy	90	10
7. It's easier to teach myself that way	70	29
8. There are a number of points I didn't understand	57	44
9. I prefer that the professor explains material related to their study	36	64
10. I learned a great deal	79	21
11. I didn't learn much	36	64
12. I did not understand the contents of the subject related to the study because it was difficult	10	90
13. I think it's a great experience	86	14

7. 7.3 Students' feedback from the first questionnaire in the first semester

Most learners appreciated the integration of the adaptation to learning styles adopted in TASAM and the support offered by the system. All of them found that the system is user-friendly. The material presented in this manner is easy and clear, and they hope that the rest of the professors use a similar method of teaching so they could learn in a way that they preferred. They also note that it is easier to teach themselves in that way. High rates were given to the media format and adaptation techniques implemented in the system. The participant's opinion to use the system in the future was very high. The feedback provided valuable positive indications of participants belonging to different learning style categories towards the system.

7. 7.4 Result of students' second evaluation questionnaire in the first semester

The evaluation questionnaire was answered by 110 students who used the TASAM teaching environment. The table shows that 48 percent of students have a background using computers and 50 percent using the Internet.

Table 7.40 shows that most students enter and browse the site related to their study from home (85 percent browse the site from home). Table 7.40 shows that students often enter and browse the site related to their study). The examples were interesting and clear (according to 62 percent of students shown the examples, these were interesting and clear). Sixty six percent of students agree that the subject presented this way makes it easy to understand. And 65 percent agree that using technology in education makes it easier (see table 7.40). For more details about the students' survey see Table 7.40.

Table 7:40: Result of Students' Second Evaluation Questionnaire in the first Semester

	Option				Missing
Questions	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**
Q1) DO you have a background on using the computer?	I know so much	sort of	a little	no idea	
	48%	45%	4%		3%
Q2) Do you have a background on using the internet?	55%	37%	5%		3%
Q3) Where can you enter and brows the site related to your study? www.adaptivelearningstyle.com?	Home	university	Home & university	other	
	85%	9%	1%		5%
Q4) Is entering and browsing the site related to your study? www.adaptivelearningstyle.com	So easy	Easy	Kind of easy	Not easy	
	33%	24%	32%	8%	3%
Q5) Was showing the subject related to your study?	35%	34%	22%	3%	6%
Q6) Showing the subject related to your study was interesting and clear?	Interesting and clear	Interesting and not clear	Clear and not Interesting	not Clear and not Interesting	
	60%	18%	15%	1%	6%
Q7) The examples were?	62%	13%	18%	1%	6%
Q8) Showing the subject this way makes it easy to understand it?	Strongly agree	agree	Don't agree much	Disagree	
	33%	33%	22%	8%	4%
Q9) Do you think using technology in education makes it easier?	21%	25%	30%	10%	14%

7. 7.5 Most Representative Electronic Media Students Prefer in their Study

The most representative electronic media that students prefer in their study are revealed in the evaluation questionnaire, which was answered by 110 students in the first semester (see Figures 7.10, 7.11, 7.12).

In figure 7.10 most students (19 percent) would like to be shown the subject materials as graphics and pictures; 17 percent as examples; 13 percent as text; 6

percent as Audio; 14 percent as slideshow and exercises; and 3 percent as video and self-test.

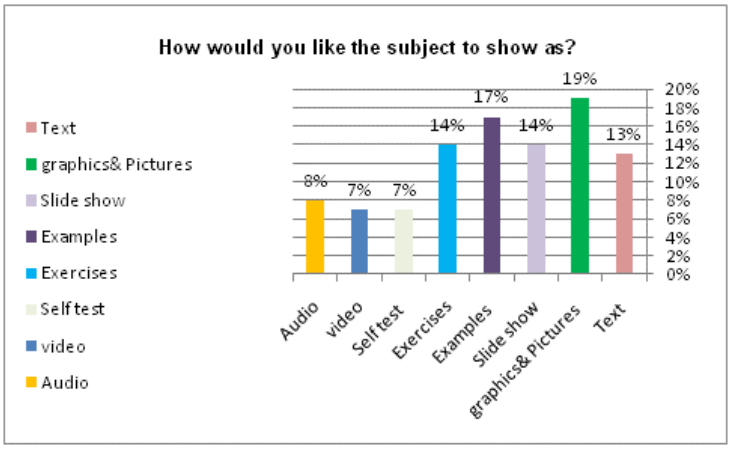

Figure 7.10: The most representative media formats if students choose subject materials

In figure 7.11 most students (35%) prefer the navigation tool as forward/back button; 14 percent the print button; 22 percent the jump button; 11 percent the home page button; and 19 percent the tree of course index

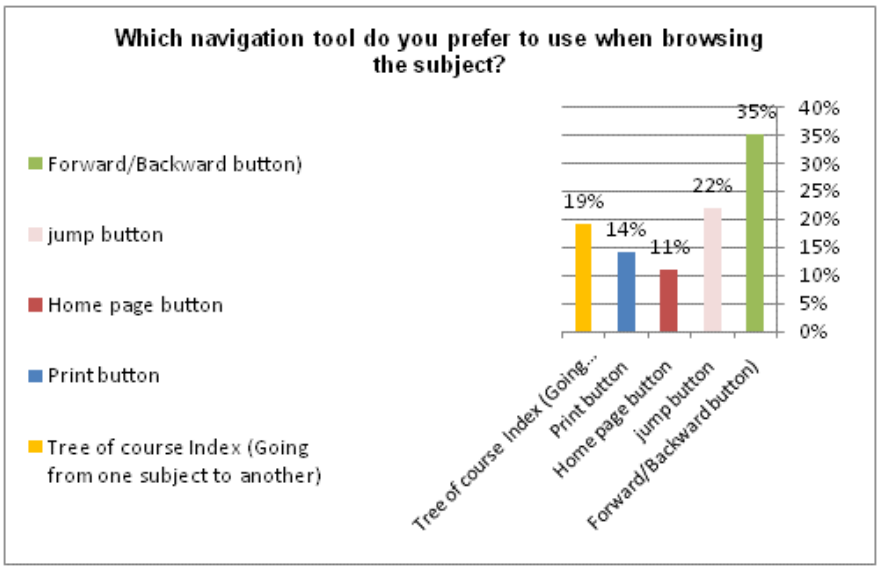

Figure 7.11: The three most representative navigation tools if students browse subject materials

In figure 7.12 most students prefer personal interview to communicate with their teacher (40%); 17 percent chat; 21 percent email; 8 percent forum; and 12 percent phone.

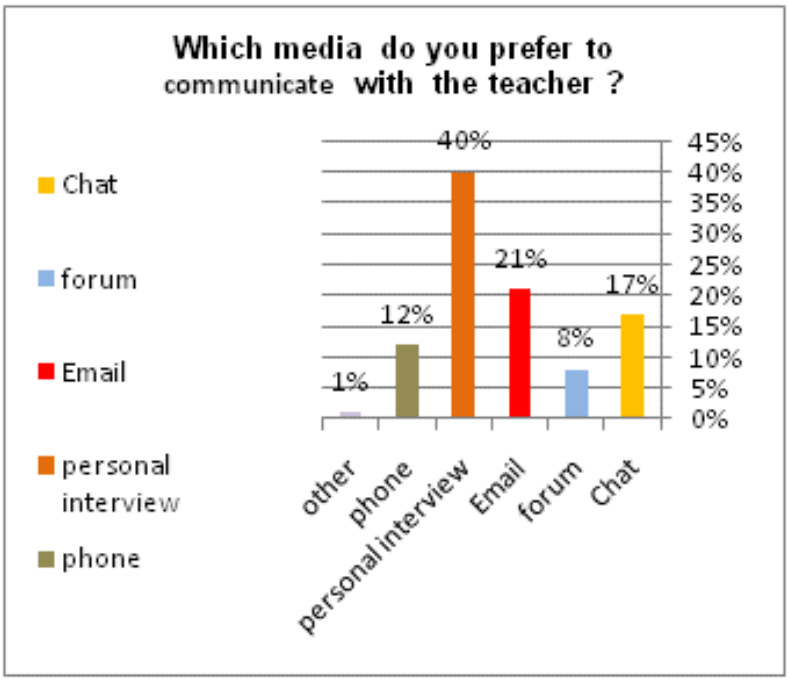

Figure 7.12: The most representative media format if student communicates with the teacher

7. 8 Results and Discussion of Final Test System (TASAM) in the second Semester

Participants consisted of 30 students from the Arts and Humanities Faculty, organised into one group. The chapters are different, but the same group.

1. The group (F) has two different cases.

   - Group (F), Case 1: using the TASAM system with no professor explanation of the chapters (Measures of Central tendency and Measures of Variability).

   - Group (F), Case 2: not using the TASAM system and only using the professor explanation of the chapter (Correlation).

7. 8.1 Results and Discussion of group (F)

H8: Group (F), Case 1 will learn significantly better than Group (F), Case 2.

The objective is to determine whether the students of Group (F), Case 1 will learn significantly better than the students of Group (F), Case 2.

Table 7:41: Paired Samples Statistics of T-TEST

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	not using TASAM	11.1667	30	4.42628	.80812
	using TASAM	12.4000	30	3.30595	.60358

Table 7:42: Paired Samples of T-Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	not using TASAM– using TASAM	-1.23333	3.23433	.59051	-2.44105	-.02561	-2.089	29	.046

The mean values for the scores of Group (F), Case 1 and Group (F), Case 2 are listed in Table 7.41, and it appears that the mean scores of Group (F), Case 1 are much higher than the mean scores of Group (F), Case 2 (12.4> 11.2). Mean values and standard deviation are also listed in Table 7.41. In Table 7.42, P=0.046 < .0.05 indicates that students of Group (F), Case 1 will learn significantly better than Group (F), Case 2.

7. 8.2 Result of students' evaluation questionnaire in the second semester

The evaluation questionnaire was answered by 54 students who used the TASAM teaching environment. The table shows that most students have a background using the computer and using the Internet.

Table 7.43 shows that most students enter and browse the site related to their study from home (96 percent browse the site from home).Table 7.43 shows that

students often enter and browse the site related to their study. As Table 5.43 shows that students found the subject related to their study interesting and clear (54 percent of students found the subject related to their study interesting and clear). The examples were interesting and clear (63 percent of students found the examples interesting and clear); 67 percent agreed that the subject presented in this way makes it easy to understand; 67 percent agreed that using technology in education makes it easier (see table 7.43). For more details about the students' survey see Table 7.43.

Table 7:43: Result of Students' Evaluation Questionnaire in the second semester

	Opetion				missing
Questions	**Percent**	**Percent**	**Percent**	**Percent**	**percent**
Q1) DO you have a background on using the computer?	I know so much	sort of	a little	no idea	
	33%	61%	6%	0%	
Q2) Do you have a background on using the internet?	48%	48%	4%	0%	
Q3) Where can you enter and brows the site related to your study? www.adaptivelearningstyle.com?	Home	university	Home & university	other	
	96%	2%	2%	0%	
Q4) Is entering and browsing the site related to your study? www.adaptivelearningstyle.com	So easy	Easy	Kind of easy	Not easy	
	44%	26%	26%	4%	
Q5) Was showing the subject related to your study?	39%	43%	15%	4%	
Q6) Showing the subject related to your study was interesting and clear?	Interesting and clear	Interesting and not clear	Clear and not Interesting	not Clear and not Interesting	
	54%	15%	28%	2%	1%
Q7) The examples were?	63%	7%	26%	2%	2%
Q8) Showing the subject this way makes it easy to understand it?	Strongly agree	agree	Don't agree much	Disagree	
	28%	39%	15%	19%	
Q9) Do you think using technology in education makes it easier?	35%	32%	17%	17%	

7. 8.3 Most Representative Electronic Media Students Prefer in their Study

The evaluation questionnaire, which was answered by 54 students in the second semester, shows the most representative electronic media they prefer in their study (see Figures 7.13, 7.14, 7.15).

In figure 7.13 most students (23%) would like to choose the subject materials as graphics and pictures; 21 percent as examples; 12 percent as exercises; 8 percent as self test; 15 percent as slideshow; 6 percent as video; 3 percent as audio; and 11 percent as text.

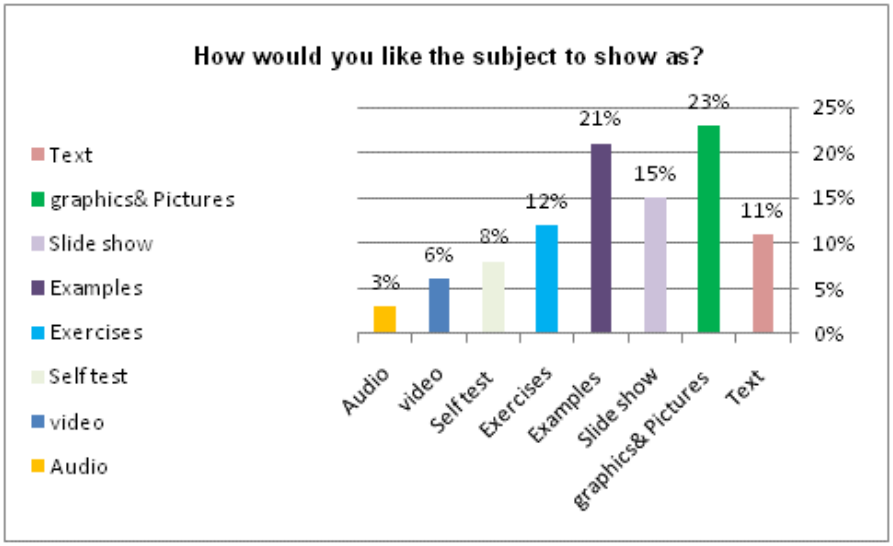

Figure 7.13: The most representative media formats if students choose subject materials

In figure 7.14 most students (31%) prefer the navigation tool as the print button; 25 percent the forward/back button; 22 percent the jump button; 6 percent the home page button; and 15 percent the tree of course Index

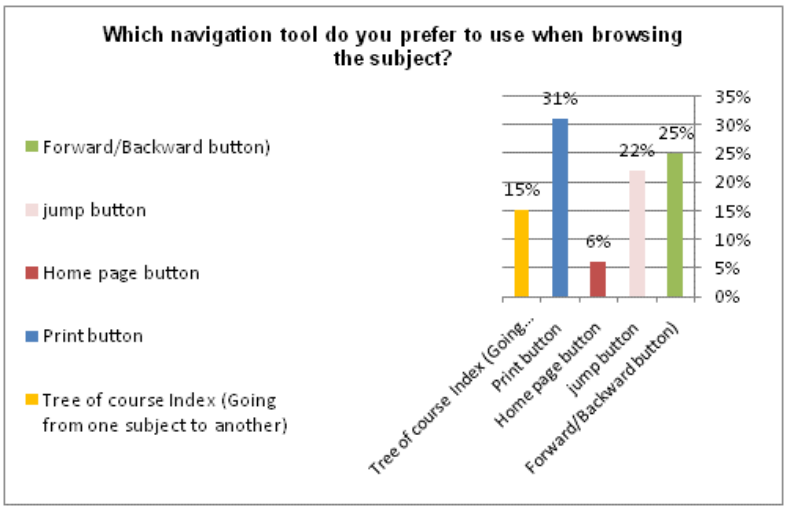

Figure 7.14: The three most representative navigation tools if students browse subject materials.

In figure 7.15 most students prefer personal interview to communicate with teacher (57%). 21 percent prefer chat. 18 percent prefer email. 4 percent prefer forum. 6 percent prefer phone. 18 percent prefer email.

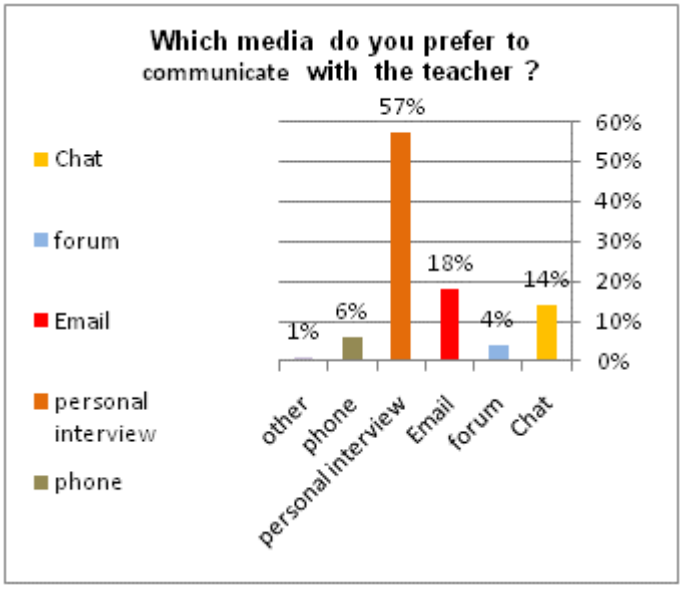

Figure 7.15: The most representative media format if student communicates with the teacher

7. 8.4 Students' Questionnaire Feedback in the First and Second Semester

Most learners stated that the TASAM system is excellent, sufficient and contains great explanation. It helps self learning and is a great way of transferring information. The design of the TASAM system is also great. Most Students hope the TASAM system can be applied to the rest of the subject's materials. It was also more helpful in the study of the subject's materials than the book. Most learners liked the TASAM system, saying that it is great in showing all concepts in detail repeatedly until it sticks in the mind. They also mentioned that the way it is organised is very interesting and it is an excellent way to make studying easy. It organised the Arabic learning system. What they liked the most about the TASAM system is that it shows detailed procedures without relying on a person's background information. Most learners said that the TASAM system was clear, easy and suitable to studies. It is very suitable to those who are practising distance learning. They also stated that the TASAM system is suitable to all sorts of students; it includes pictures, drawings and examples, which means that students do not need professors.

Most learners appreciated the integration of the adaptation to learning styles adopted in TASAM and the support offered by the system. All of them thought that the system is user-friendly; they mentioned that the material presented in this manner

is easy and clear and hoped that the rest of the professors used a similar method of teaching so they can learn in a way that they prefer and understand. High rates were given to the media format and adaptation techniques implemented in the system. The participant's opinion to use the system in the future was very high. The feedback provided valuable positive indications of participants belonging to different learning style categories towards the system. Overall, the students seemed to have enjoyed using the TASAM system and there seemed to have been a positive impact on their learning performance. The evaluation of the TASAM system was very fruitful for both its objectives. Students managed to achieve adequately the learning objectives and to provide feedback of high quality to the development team for the system evaluation. The feedback together suggests that students do have different strengths and preferences and the challenge is to find the best way to adapt to this diversity. It suggests that a wide approach to learning is necessary so that all students can find something attractive and beneficial.

7. 8.5 Suggestion of student after feedback

Five students suggested TASAM system requires professor's explanation or some professors assisting. They mentioned that it needs to be faster and more precise. Two students said that the TASAM is not suitable to Statistics because it requires detailed and easy to understand explanation and developing. A few students said that the TASAM system needs time so students can get used to it. They also said that it was concentrating on the visual personality, which made other personalities obsolete.

7.9 Summary

This chapter is divided into eight different sections. The first section is the introduction. The second covers findings and analysis of the reliability and validating the Felder-Soloman Index of learning styles in Arabic. The third section provides the results and analysis of comparing Arabic students in different faculties with different learning styles. The fourth section presents the results and analysis of results and discussion of trial test of system (TASAM) conducted in this study. The fifth section

explores results and discussion of trial evaluation. The sixth section provides results and discussion of final test system (TASAM) in the first Semester. The seventh section presents results and discussion of the final evaluation questionnaire in the first semester, and the last section discusses the results and discussion of the final test system (TASAM) in the second semester.

CHAPTER 8
DISCUSSION

8.1 Introduction

This study set out to answer the research questions mentioned in the first chapter:

1. Which Leaning Styles instrument would be appropriate for developing an Arabic adaptive learning system?
2. How can a validated Arabic version of Leaning Styles instrument be produced?
3. How can the validated instrument be applied to an adaptive learning system?
4. How can an e-learning environment adapt itself to accommodate individual learning styles?
5. What is the impact on learning performance when learning materials are matched and mismatched with learning styles of a student?

In order to answer the research questions the following three key objectives were identified:

- To develop an adaptive learning system for Arabic speaking communities as well as to provide a firm base for developing an adaptive learning system based on the Felder-Soloman Index of Learning Styles for non-English speaking students.
- To discuss the development of a translation protocol undertaken to improve the validity and internal reliability of the Arabic version of the ILS. This includes internal consistency reliability, test-retest reliability and factor Analysis.
- To compare responses to two Arabic speaking groups in different faculties at the King Abdul-Aziz University in Saudi Arabia: The Arts and Humanities Faculty and the Economics and Administration Faculty.

Also, this chapter covers the examination of a study of the reliability and validating the Felder-Soloman index of learning styles in Arabic and the discussion of experimental design and evaluation.

8.2 A study of the reliability and validating the Felder-Soloman index of learning styles in Arabic

In summary, we recommend that for a scale to be judged as having excellent content validity, it must be composed of items with I-CVIs, that any item would not meet the .86 level of endorsement is required to establish content validity using a panel of eight experts. It must also be rewritten. The reliability estimate of the scores for the four scales of the ILS is based on the sample of 170 students per pilot study. In the initial translation, the value of Cronbach's alpha was poor for Active/ Reflective, Sensing/ Intuitive and Sequential/ Global dimensions, ranging from 0.314 to 0. 0.361. Classical item analysis indicated that the reliability of the scale scores can be improved by elimination of the weakest item in each scale, with the greatest benefit occurring for the Visual-Verbal scale, which went to 0.629.

A method was devised to Improve Internal Consistency Reliability, which consisted of refining the instrument by using expert input on the translation (by bilingual experts) and the question constructs (by psychologist experts) and by trialing the updated instrument with a sample of 20 Economics and Administration students and 30 bilingual students. The internal inconsistency of the Arabic version of the instrument increased as evidenced by the Cronbach alpha values, which compare favourably with values obtained in previous studies.

Factor analysis of the ILS identified eight factors associated with the four scales. Analysis of the underlying construct, with input from psychologist experts, for each of the factors revealed that they are appropriately matched to the intent of the scales, providing evidence of construct validity for the instrument. In the light of the previous analysis and findings, we suggested a general protocol for translation and adaptation of instruments intended for cross-cultural use that will improve the

reading comprehension of the instrument, reducing cultural sensitivity as well as increasing the validity and reliability of the instrument.

In this research we have presented the detailed translation procedure used in developing the Arabic version of the ILS questionnaire. The formation of a multidisciplinary research consultative group, translation, piloting and back translation proved to be very helpful in developing the Arabic version of ILS questionnaire for learning styles in King Abdul-Aziz University in Saudi Arabia. The pilot study showed that it worked well, although some minor changes had to be made in finalising the Arabic version of the ILS questionnaire to increase its technical equivalence. Forward translation is an inexpensive and less time consuming method of translation compared to other methods of translation, for example, committee translation.

In this research, the preliminary translation developed from forward translation helped in stimulating discussion among members of the local expert group in the committee translation stage. Not only did this process save time, it also provided an opportunity to assess and critique the preliminary translation of the Felder-Silverman learning style instrument. The local multi-disciplinary expert committee had long standing practical experience in translating questionnaires for use in the field situation and had a good reputation within the community. Both these factors impacted positively on maintaining the quality of the Arabic version of the ILS questionnaire translation of the English version of the ILS questionnaire. Indeed, the quality of the translation depends heavily on qualifications, knowledge and cultural experience of the translators as well as their awareness about the research goal, concepts of interest and purpose of the items.

In committee translation, more emphasis was placed on thematic translation rather than word-for-word translation, which can often be inadequate in addressing linguistic and cultural differences. It was noted by the committee that item 2 and item 6 in the English version of the ILS questionnaire scale were relatively difficult to express in Arabic. Through using eleven sequential stages such as a literature review

of publications on the culture of the original instrument and the target population, discussion with participants, back translation and evaluation of the semantic equivalence between the back and pilot testing in the target participants and revision, it was possible to refine and improve the translation procedure.

The Cronbach's alpha coefficient was calculated for each of the four scales of the ILS based on the sample of 532 students of the Arts and Humanities Faculty, the sample of 492 students of the Economics and Business Administration Faculty and the sample of 1024 students of the Economics and Business Administration Faculty and the Arts and Humanities Faculty. Comparing the results of the current study with those of past studies reported by Felder and Spurlin (2005), the Cronbach alpha values obtained in this study show a similar pattern. Factor analysis of the ILS identified eight factors associated with the four scales. Analysis of the underlying construct, with input from psychologist experts, for each of the factors, revealed that they are appropriately matched to the intent of the scales, providing evidence of construct validity for the instrument. It is hoped that the documentation of the rigorous scientific application of a rational translation process in developing the Arabic version of the ILS questionnaire scale will be useful in similar settings where screening questionnaires need to be translated and adapted for local use.

Overall, the instrument translation procedure presented provides guidance and a practical framework to help researchers robustly apply a cross cultural adaptation of instruments. The guidance is informed by applying the instrument translation procedure to develop an Arabic version of the Felder-Silverman learning style instrument and use this to examine the learning styles of a significant number of people (1024 Arabic speaking students). Though the procedure focused on the translation of an English based instrument to Arabic, the procedure could be applied to other translations. Some of the key novelties of the procedure are practical ways to validate the translation process.

8.3 Experimental Design and Evaluation

Building Adaptive Educational Systems that acknowledge different learning characteristics can be challenging. This research describes the development and testing of the first Arabic adaptive learning system – the Teacher Assisting and Subject Adaptive Material (TASAM) system. The system dynamically tailors the learning environment, after the student fills out a questionnaire of the Felder-Silverman learning style, to match the individual learning preferences of individuals. This research has also aimed to show the developmental processes involved in producing such an adaptive system, including: the validation of the learning style instrument; the practicalities of identifying appropriate courses and engaging staff and students; the development of learning strategies and corresponding learning material; and the testing of the system and impact on learning before its mainstreaming.

Measuring the effect of providing educational experiences individualised to the learning style of the students is an open research issue: there are many potential influences on any learning achieved other than the adaptive learning system. This research hopes to make a contribution by presenting a case study of a dedicated adaptive educational system and providing guidance and discussion on both development issues and how to evaluate the effectiveness of an adaptive learning system. The validity and effectiveness of the system are assessed by means of an empirical evaluation approach, involving experimenting with groups of students over three semesters, as follows:

In the trial test the participants consisted of 80 students from the Arts and Humanities Faculty divided into three different groups:

1. Group A consisted of 22 students who were given the chapter covering the T-Test to work through in the TASAM system. The professor did not explain the chapter.
2. Group B consisted of 18 students who were given the T-Test chapter to work through in the TASAM system. A teacher, however, explained the chapter.

3. Group C consisted of 40 students who were given the teacher's explanation of the T-Test chapter (i.e. without using the TASAM adaptive system).

Testing comparisons consisted of the following:

1- Compared Group A with Group B. The same chapter, but different groups.
2- Compared Group A with Group C. The same chapter, but different groups
3- Compared Group B with Group C. The same chapter, but different groups.

The hypotheses state that there are at least one significant difference between the three groups:

H0: group (B) will learn significantly better than group (A).
H1: group (A) will learn significantly better than group (C).
H2: group (B) will learn significantly better than group (C).

The results indicate that there are significant differences between the mean scores of Group C and Group A (P=0.012). Moreover, there are significant differences between the mean scores of Group C and Group B (P=0.036). This indicates that students in Groups A and B will get significantly higher scores in the exam and learn better than students in Group C.

In the final test system (TASAM) in the first semester, the participants consisted of 53 students from the Arts and Humanities Faculty, organised into two groups:

1. Group D consisted of 28 students and four different cases. The chapters were different, but the group was the same.
    - Group D, Case 1: students using the TASAM system with no professor explanation of the chapter (Measures of Variability and Correlation)
    - Group D, Case 2: students not using the TASAM system and only using the professor explanation of the chapter (Central tendency)

- Group D, Case 3: students using the TASAM system with professor explanation of the chapter (Measures of Variability and Correlation)
- Group D, Case 4: students using the TASAM system with no professor explanation of the chapter (Correlation)

2. Group E consisted of 25 students and three different cases.
    - Group E, Case 1: students using the TASAM system with no professor explanation of the chapter (Measures of Variability and Central tendency statistics)
    - Group E, Case 2: students not using the TASAM system and only using the professor explanation of the chapter (Correlation)
    - Group E, Case 3: students using the TASAM system with professor explanation of the chapter (Measures of Variability and Central tendency statistics)

Testing comparisons consisted of the following:

1. Compared Group D, Case 1 with Group D, Case 2. The chapters were different, but the group was the same.
2. Compared Group D, Case 1 with Group D, Case 3. The same chapters and group.
3. Compared Group E, Case 1 with Group E, Case 2. The chapters were different, but the group was the same.
4. Compared Group E, Case 1 with Group E, Case 3. The same chapters and group.
5. Compared Group D, Case 4 with Group E, Case 2. The chapters were the same, but the groups were different.

The hypotheses are as follows

H3: Group (D), Case 1 will learn significantly better than Group (D), Case 2

H4: Group (D), Case 1 will learn significantly better than Group (D), Case 3

H5: Group (E), Case 1 will learn significantly better than Group (E), Case 2

H6: Group (E), Case 1 will learn significantly better than Group (E), Case 3

H7: Group (D), Case 4 will learn significantly better than Group (E), Case 2

The results indicate that students of Group D, Case 1 will learn significantly better than students of Group D, Case 2 (P =.045 < 0.05). The results also indicate that there are no significant differences between Group D, Case 1 and Group D, Case 3 (P =.462 > 0.05).

The results indicate that students of Group E, Case 1 will learn significantly better than students of Group E, Case 2 and there was a very significant difference between Group E, Case 1 and Group E, Case 2 (P =0.03 < .05).

The results also indicate that there was no significant difference between Group E, Case 1 and Group E, Case 3 (P =0.46 > .05). In addition, in the final test system (TASAM) in the first semester, Group D, Case 4 was compared with Group E, Case 2 (the same chapter, but different groups) (P =0. 048 < .0.05). This indicates that students of Group D, Case 4 will learn significantly better than students of Group E, Case 2.

In the final test system (TASAM) in the second semester, the participants consisted of 30 students from the Arts and Humanities Faculty, organised into one group. The chapters were different, but the group was the same.

1. Group F had two different cases.

- Group F, Case 1: using the TASAM system with no professor explanation of the chapter (Measures of Central tendency and Measures of Variability).

- Group F, Case 2: not using the TASAM system and only using the professor explanation of the chapter (Correlation).

Testing comparisons consisted of the following:

1. Compared Group F, Case 1 with Group F, Case 2

The hypothesis is as follows

H8: Group (F), Case 1 will learn significantly better than Group (F), Case 2

The results indicate that students of Group F, Case 1 will accomplish significantly higher exam scores and learn better than Group F, Case 2 (P =0.046 < .0.05).

The results of the TASAM application suggest that participating students with low scores can improve their performance when adaptive presentation strategies are in use. There is clearly much potential for mainstreaming adaptive learning systems to larger groups of leanings at minimal marginal cost.

This study evaluated the impact of the incorporation of learning styles on the educational hypermedia of statistics course. With its emphasis on students of the Arts and Humanities Faculty at the King Abdul-Aziz University, the main hypotheses postulated, regarding the main score differences, were found to be particularly pertinent and well founded. The findings suggest that students benefit from the learning materials being adapted to suit their learning preferences and reveal that students have obvious different preferences for lesson presentation type. They also suggest that the learning outcomes can be improved if designers of the hypermedia statistics course provide a different sequence and presentation of materials to accommodate individual learning style differences. Hence, possibilities for promoting more effective learning are the solid results; these indicate that learning styles provide a good basis with which to adapt hypermedia to individual needs. Hypermedia design features, based on students' learning styles, such as adaptive taxonomy, learning style (LS) dimensions and electronic media (EM) relationships for statistics course material and linking mechanisms, have significant bearing on the future development of adaptive hypermedia systems.

The results of experiments should obtain useful and actionable knowledge that could be used by an adaptation system of a TASAM. Findings showed that students learning using the system with adaptation to learning style performed significantly better in academic achievement than students taught the same material

without adaptation to learning style ($p<0.05$) in our study. This is generally in agreement with the many models provided by literature; for example, models ILASH and LSAS used the same group, but different courses or chapters, and other models such as EDUCE used different groups but the same chapters. The findings supported the use of learning styles as guidelines for adaptation into the adaptive e-learning hypermedia systems. The students were satisfied with the preferred learning style and willing to use the system in the future.

We evaluated the TASAM system in two phases: first, presenting the perception of teacher and students by using the information obtained through the surveys. Four teachers who used the TASAM teaching environment answered the teachers' evaluation questionnaire. Overall, teachers seemed to have enjoyed using the TASAM system and there seemed to have been a positive impact on learning performance. The students' evaluation questionnaire was answered by 32 students who used the TASAM teaching environment in the initial test system (TASAM). This was also answered by 110 students who used the TASAM teaching environment in the first semester and 130 students who used the TASAM teaching environment in the second semester.

We found the electronic media students preferred through the evaluation questionnaire; 32 answered in the trial test system (TASAM) and 164 in the first and second semester. A significant number of students (27%) would like the subject shown as graphics and pictures in the trial test system (TASAM); and 19 percent as graphics and pictures in the first semester and 23 percent in the second semester. A significant number of students (49%) prefer the navigation tool as the forward/back button; 29 percent the print button if students choose subject materials in the trial test system (TASAM); 35 percent the forward/back button; 14 percent the print button in the first semester and 25 percent the forward/back; and 31 percent the print button in the second semester. A significant number of students prefer personal interview to communicate with the teacher (40%) in the first semester and 57 percent in the second semester, but in the trial test system (TASAM), a significant number of students prefer phone to communicate with the teacher.

Feedback adaptation in the TASAM context has been studied using very selective samples of participants (a relatively small number, all female and all at the same university). In addition, there may be other factors that could affect students' performance using the TASAM system, such as students' level of information technology (IT) skills, whether they like using computers or not or previous knowledge in the topic. Therefore, the results of our summarising analysis of recommendations are highly speculative and await further validation in extensive experimental studies. These experimental studies are necessary to discover the positive patterns of relations between individual LSs and the adaptable feedback parameters increasing the efficiency of interaction and learning processes.

8.4 Summary

This chapter extends the current debate and knowledge based on the translation of research instruments by presenting a procedure used for translation and cultural adaptation of an Arabic version of the Felder-Silverman learning style instrument (FSLSI). The procedure presented provides guidance and operational framework to help researchers robustly apply a cross cultural adaptation of instruments. This Arabic version of the FSLSI was applied to a selection of female students at King Abdul-Aziz University in Saudi Arabia, representing two faculties (Arts and Humanities and Economics and Administration), to form a study covering 1024 students. The procedure presented provides extensions of validating instruments, using such items as content validity and factor analysis, within the translated language, and is particularly aimed at Arabic communities, though the generic procedure can be applied to other cultures and languages.

This chapter presented an approach to integrate learning styles into an adaptive e-learning hypermedia system and an approach to evaluate the impact of such a learning system. This research hopes to make contribution by presenting a further case study of a dedicated adaptive educational system and providing guidance and discussion on both development issues and how to evaluate the effectiveness of an adaptive learning system. Existing adaptive learning systems are predominantly

English based. This chapter hopes to make further contribution by bringing adaptive learning capability to on-English speaking communities.

CHAPTER 9
CONCLUSION, CONTRIBUTION AND RECOMMENDATIONS

9.1 Introduction

The literature on learning styles is dominated by the US, Europe and Japan (Aljojo and Adams 2009, Aljojo et al., 2009). However, to date, to our knowledge, there have been no studies on learning styles for Middle Eastern undergraduate students and very little work focusing on Arabic speaking communities. Middle Eastern communities have different education systems and learning experiences to other regions. For instance, the Arabic language is written from right to left as opposed to left to right in English and European languages. It is not clear if the same learning styles instruments are suitable for the Arabic speaking communities. The research uses a robustly translated and validated Arabic version (Aljojo et al., 2009) of the Felder-Silverman's Index of Learning Styles (Felder and Soloman, 2003), and applies this to two groups of female students, from different faculties within the King Abdul-Aziz University in Saudi Arabia. The two faculties of Arts and Humanities and Economics and Administration provide a cross section of topic interest and are correspondingly likely to provide a sample of diverse learning style preferences within the Saudi Arabian community.

This chapter summarises the work conducted within this thesis. In the next subsection, a summary of the performed research is given and the contributions of this work are highlighted. Subsequently, the limitations of the research work are described. The thesis concludes with a discussion on future work.

9.2 Contributions of the research

The research reported in this thesis has made some important contributions to knowledge in the area of adaptive hypermedia. The main contributions are discussed below.

9.2.1 Producing a validated Arabic version of the Felder-Silverman Learning Style Instrument

Works on Learning Styles have been dominated by application in English speaking communities and a Western mindset. The instruments have been typically written in English for a Western culture. Little work has been done in applying such learning styles instruments to other languages and communities, such as Arabic and Middle Eastern cultures. The main contributions of producing a validated Arabic version of the Felder-Silverman learning style instrument are discussed below:

- This research has produced the first validated Arabic version of the Felder-Silverman Learning Style Instrument (FSLSI).
- In addition, the research has developed a translation process that captures language translation as well as constructed translation between cultures.
- The research also provides the first direct comparison of learning styles between English and Arabic learners by comparing Arabic response to previous works. Further comparisons have also been made between other language (Spanish, Italian).
- Applied the Arabic version of the Felder-Silverman Learning Style Instrument (FSLSI) to a significant group of Arabic speaking learners (1024) to produce the dataset covering learners in Arabic.
- Provides comparison of learning styles between two different groups of Arabic students in different faculties.
- The research has also contributed to the debate on learning styles, particularly covering the following questions.

    - ❖ Can the construct of learning styles be used across cultures?
    - ❖ Do different cultures have different learners in learning styles?
    - ❖ Which attributes of learning are best suited to inform adaptive learning systems?

9.2.2 Development of First Arabic Adaptive Learning System

The main contributions of the development of the first Arabic adaptive learning system can thus be summarised:

- A significant contribution of this research has been the production of a Teacher Assisting and Subject Adaptive Material (TASAM) system, which is the first Adaptive learning system that is informed will a validated Arabic learning Style instrument (LSI).
- One of the main aims of this research was to develop and test an Arabic adaptive learning system to help Arabic speakers in the learning community.
- The research has tested and retested the system and applied it to groups of students over three semesters.

  In addition, the research has made contribution by
- Robust processing to measure the effectiveness of adaptive learning systems using both formative and summative criteria.
- Informed theory on how to make and measure an adaptive learning system.
- Produced a comparison of the performance of three groups with different levels of involvement from the TASAM system and the professor.
- Provided practical guidance on developing and applying adaptive learning systems.

9.3 Limitations of the Research

In the light of some interesting findings, it must be recognised that there are limitations to the significance of the research. When considering these issues, it must also be noted that the issues involved in developing an adaptive educational system to support individual trait differences are very complex.

- Only a limited number of people were surveyed, most of whom were female and from the same two faculties of King Abdul-Aziz University in Saudi Arabia. It may be worth confirming the result with uneducated people and those from other countries or disciplines.

- Content was only developed for one domain – statistics. To improve the results, particularly that which showed that presenting resources students do not prefer can enhance learning, it would be necessary to develop content for different domains by different content authors.
- Learners could not switch between styles and instead had to stay with a particular style.
- There was only a small number of test subjects; 123 students. To generalise the results it would be necessary to conduct experiments with a greater number of people. In addition, the range of universities studied was limited. One study was conducted in just one university (King Abdul-Aziz University in Saudi Arabia) and students from one faculty (Arts & Humanities).
- The sample population was not random.
- The age of group in the experiment older than 17.
- The duration of the experiment was short. Each session was about an hour and a half and 30 days or less for the experiment. To observe student preferences with greater accuracy, it would be necessary to extend the duration of the experiment and develop more content.

9.4 Suggestions for Future Research and Recommendations

In future, more work could be done on providing adaptivity in more detail. For example, investigations can be performed on finding out whether there are certain features of adaptation that can be more effective than others, or whether there are learning styles which can be better supported by the proposed concept than others.

Another aim of future research will be to extend the concept in terms of making it more generic. Currently, the concept is based on a limited and predefined course structure, including six types of learning objects (content, outlines, conclusions, examples, self-assessment tests and exercises) as well as predefined adaptation features based on these types of learning objects. Future work can allow

teachers to define which types of learning objects they want to include in the adaptation process as well as define respective adaptation features. This will allow teachers to use their courses as they are intended and only adjust the adaptation mechanism to suit their courses rather than the other way around. Teachers will be able to include all desired features of the respective adaptive website regardless of whether these features are commonly used or not.

Another direction of future work will be to combine the different parts of research by joining the automatic detection of learning styles with the functionality to provide adaptive courses. The dynamic student modelling approach can be used to monitor students' behaviour and performance in order to intervene when students seem to need support. By asking students about whether a course should be adapted and giving them some choices based on their learning styles for adapting the course, the system can provide for them and use the students' choices as valuable feedback. From the behaviour of students in the adapted courses, the system can again get feedback about the performed adaptation. Based on the gathered feedback, the system is able to learn the students' needs and incrementally develop an accurate and reliable student model. This will allow the system to provide students with courses where adaptation is frequently improved in order to fit the students' needs.

This subchapter offers recommendations for future researchers who are interested in further investigating the benefits of learning styles. Improvements in the experimental design could support the findings reported in this study and increase their external validity. To improve further reliability similar comparative studies could be carried out with a larger or a different sample population, other types of learning content and a random sample of participants, rather than a convenience sample.

TASAM proposed a new, dynamic approach to adaptive behaviour in learning style-responsive environments. Even though the source code was written specifically for the statistics course that was used in the experimental evaluation, it is conceivable that with moderate programming effort, adapted versions of TASAM

can be created for other domains. Future studies could focus more specifically on assessing the influence of prior experience (with computers and the Internet) and interest (in the knowledge domain) on the effect of learning performance. More accurate, valid and reliable measurement tools could be developed to assess experience and interest, and these tools could then be shared with other studies to facilitate comparable findings. Additionally, future studies could investigate whether there are more factors which also have an influence on the effect of learning performance. Possible candidates could be mood or stress level.

Future research could employ a more sophisticated adaptation mechanism, such as an adaptive Bayesian modifier (Castillo et al., 2003), which uses a more detailed learner model. Additionally, a collaborative matching mechanism (Zukerman & Albrecht, 2001; Jameson, 2002) could be devised under the assumption that learners with comparable initial profiles have similar preferences under similar conditions. Collaborative matching was successfully used in other adaptive educational hypermedia environments, such as Arthur (Gilbert, 2000).

There are clearly further avenues for research in applying the Arabic version of the Soloman-Felder ILS instrument, as well as other learning style instruments, to other groups of Arabic speaking learning environments. The next phase of this research is to compare the Arabic responses to the Soloman-Felder ILS instrument with responses from other works covering different learning groups around the globe. There are clearly interesting areas to investigate such as how homogeneous are learning styles for different groups of people around the world. The results from the Arabic samples in this study indicate some preferences towards particular learning styles, and it would be interesting to compare learning style preferences with other groups around the world. A further avenue for research is to apply the Arabic version of the Soloman-Felder ILS to inform the development of adaptive and supportive learning systems.

9.5 Final Conclusions

In this research, a guide for the process of adapting the Arabic version of Felder-Silverman Learning Style Theory (LST) for use in a different setting has been presented (Chapter Four). The need has also been acknowledged for psychometric testing and normative data collection using the new instrument. The choice was to separate the adaptation from the testing, because the need for additional testing is the same as after any adaptation of another existing questionnaire, whether it be shortening it or performing a cross-cultural adaptation.

The most significant result of this study is that the application of the robustly translated Arabic version of the Soloman-Felder ILS instrument shows internal consistency. There are now strong grounds for the Arabic version of the Soloman-Felder ILS to be used as a measure for capturing and understanding learning styles of Arabic speaking learners. This now provides a base for using the Soloman-Felder ILS instrument to inform Arabic applications of technology-supported learning activity and adaptive learning systems, and general teaching and learning research based on learning styles within Arabic-speaking learning environments.

There are clearly further avenues for research in applying the Arabic version of the Soloman-Felder ILS instrument, as well as other learning style instruments, to other groups of Arabic-speaking learning environments. The next phase of this research is to compare the Arabic responses to the Soloman-Felder ILS instrument with responses from other works covering different learning groups around the globe. There are clearly interesting areas to investigate, such as how homogeneous are learning styles for different groups of people around the world. The results from the Arabic samples in this study indicate some preferences towards particular learning styles, and it would be interesting to compare learning style preferences with other groups around the world. A further avenue for research is to apply the Arabic version of the Soloman-Felder ILS to inform the other development of adaptive and supportive learning systems.

The Teacher Assisting and Subject Adaptive Material (TASAM) system is used by Arabic-speaking undergraduate students on a statistics course at the King Abdul Aziz University in Saudi Arabia from a technical perspective. The system development involved the combination of an SQL server 2005 and SQL database, and Active Server Pages were used to implement the system based on learning styles to present the appropriate subject matter, including the content, teaching strategies and electronic media. The system was organised into three models: the domain, learner and adaptation models. The three models interact together to perform adaptively.

Once a system is up and running, extra students can have access to tailored teaching material at minimal cost. The TASAM example presented in this research is the first applied to Arabic-speaking learners. Examples of adaptive learning systems applied to other languages and used in other cultures would improve our understanding of adaptive learning systems and the impact on learning performance and processes. There are still challenges in testing the impact of adaptive systems, particularly over longer periods of time since there are many potential influences on learning performance.

Using TASAM, an experiment was designed to explore the effects of adaptation to different learning styles and to determine the effect of learning style adaptation on overall achievement. In particular, it was set up to determine whether there is a significant difference in learning achievement between three test groups: an experimental group who studied with adaptation to learning styles, a group who studied with another version of the system without adaptation to learning styles and an experimental group who studied with adaptation to learning styles and explanations by the professor. In summary, this exegesis compiled a snapshot of the current status of learning-style adaptive e-learning environments, as a result of a critical review of the learning styles literature and existing environments. This approach was implemented by creating an environment that provided learners based on learning styles of students. Then the environment was experimentally evaluated

by results from empirical studies that support the effectiveness of adaptive presentation strategies for learners.

The findings supported the use of learning styles as guidelines for adaptation into the adaptive e-learning hypermedia systems. The students were happy to learn within their preferred learning style and willing to use the system in the future.

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Appendix A: Index of Learning Styles Questionnaire

A1: Index of Learning Styles Questionnaire in English

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

1. I understand something better after I
- **a)** Try it out.
- **b)** Think it through.

2. I would rather be considered
- **a)** Realistic.
- **b)** Innovative.

3. When I think about what I did yesterday, I am most likely to get
- **a)** A picture.
- **b)** Words.

4. I tend to
- **a)** Understand details of a subject but may be fuzzy about its overall structure.
- **b)** Understand the overall structure but may be fuzzy about details.

5. When I am learning something new, it helps me to
- **a)** Talk about it.
- **b)** Think about it.

6. If I were a teacher, I would rather teach a course
- **a)** That deals with facts and real life situations.
- **b)** That deals with ideas and theories.

7. I prefer to get new information in
- **a)** Pictures, diagrams, graphs, or maps.
- **b)** Written directions or verbal information.

8. Once I understand
a) All the parts, I understand the whole thing.
b) The whole thing, I see how the parts fit.
9. In a study group working on difficult material, I am more likely to
a) Jump in and contribute ideas.
b) Sit back and listen

10. I find it easier
a) To learn facts.
b) To learn concepts.

11. In a book with lots of pictures and charts, I am likely to
a) Look over the pictures and charts carefully.
b) Focus on the written text.

12. When I solve math problems
a) I usually work my way to the solutions one step at a time.
b) I often just see the solutions but then have to struggle to figure out the steps to get to them.

13. In classes I have taken
a) I have usually gotten to know many of the students.
b) I have rarely gotten to know many of the students.

14. In reading nonfiction, I prefer
a) Something that teaches me new facts or tells me how to do something.
b) Something that gives me new ideas to think about.

15. I like teachers
a) Who put a lot of diagrams on the board.
b) Who spend a lot of time explaining.

16. When I'm analyzing a story or a novel
a) I think of the incidents and try to put them together to figure out the themes.
b) I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

17. When I start a homework problem, I am more likely to
a) Start working on the solution immediately.
b) Try to fully understand the problem first.

18. I prefer the idea of
a) Certainty.
b) Theory.

19. I remember best
a) What I see.
b) What I hear.

20. It is more important to me that an instructor
a) Lay out the material in clear sequential steps.
b) Give me an overall picture and relate the material to other subjects.

21. I prefer to study
a) In a study group.
b) Alone.

22. I am more likely to be considered
a) Careful about the details of my work.
b) Creative about how to do my work.

23. When I get directions to a new place, I prefer
a) A map.
b) Written instructions.

24. I learn
a) At a fairly regular pace. If I study hard, I'll "get it."
b) In fits and starts. I'll be totally confused and then suddenly it all "clicks."

25. I would rather first
a) try things out.
b) think about how I'm going to do it.

26. When I am reading for enjoyment, I like writers to
a) Clearly say what they mean.
b) Say things in creative, interesting ways.

27. When I see a diagram or sketch in class, I am most likely to remember
a) The picture.
b) What the instructor said about it.

28. When considering a body of information, I am more likely to
a) Focus on details and miss the big picture.
b) Try to understand the big picture before getting into the details.

29. I more easily remember
a) Something I have done.
b) Something I have thought a lot about.

30. When I have to perform a task, I prefer to
a) Master one way of doing it.
b) Come up with new ways of doing it.

31. When someone is showing me data, I prefer
a) Charts or graphs.
b) Text summarizing the results.

32. When writing a paper, I am more likely to
a) work on (think about or write) the beginning of the paper and progress forward.
b) Work on (think about or write) different parts of the paper and then order them.

33. When I have to work on a group project, I first want to
a) Have "group brainstorming" where everyone contributes ideas.
b) Brainstorm individually and then come together as a group to compare ideas.

34. I consider it higher praise to call someone
a) Sensible.
b) Imaginative.

35. When I meet people at a party, I am more likely to remember
a) What they looked like.
b) What they said about themselves.

36. When I am learning a new subject, I prefer to
a) Stay focused on that subject, learning as much about it as I can.
b) Try to make connections between that subject and related subjects.

37. I am more likely to be considered
a) Outgoing.
b) Reserved.

38. I prefer courses that emphasize
a) Concrete material (facts, data).
b) Abstract material (concepts, theories).

39. For entertainment, I would rather
a) Watch television.
b) Read a book.

40. Some teachers start their lectures with an outline of what they will cover. Such outlines are
a) Somewhat helpful to me.
b) Very helpful to me.

41. The idea of doing homework in groups, with one grade for the entire group,
a) Appeals to me.
b) Does not appeal to me.

42. When I am doing long calculations,
a) I tend to repeat all my steps and check my work carefully.
b) I find checking my work tiresome and have to force myself to do it.

43. I tend to picture places I have been
a) Easily and fairly accurately.
b) With difficulty and without much detail.

44. When solving problems in a group, I would be more likely to
a) Think of the steps in the solution process.
b) Think of possible consequences or applications of the solution in a wide range of areas.

A2: Index of Learning Styles Questionnaire in Arabic version

استبانة أساليب التعلم

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استمارة رقم {٦}

مؤشر أساليب التعلم

عزيزتي الطالبة

أشكرك على اقتطاع بعضاً من وقتك الثمين للإجابة على استبانه هذا البحث المقدم من الباحثة نهلة محمد الجوجو للحصول على درجة الدكتوراه في مجال نظم المعلومات، وتهدف هذه الاستبانة إلى التعرف على أساليب التعلم الخاصة بك، ولذا نأمل منك تحري الدقة في الإجابة على بنود الاستبانة باختيارك أقرب إجابة تعكس الواقع. كما يسرني إعلامك–إن رغبت– بنتيجة المقياس الذي يكشف عن أساليب التعلم الخاصة بك وإرساله لك عن طريق البريد الالكتروني حال توفره.

ومن أهداف البحث تحديد أفضل أساليب التعلم ، مما يضمن مخرجات تعليمية على درجة عالية من الكفاءة العلمية، ومما يضمن ثراء العملية البحثية ، التي تهدف إلى الوصول إلي أفضل الأساليب التعليمية، وبالتالي تقديم كوادر علمية قادرة على تطوير المجتمع.

وبناءً على إجابتك ونتائج البحث ستقوم الباحثة برفع مقترحات و توصيات البحث إلى جامعة الملك عبد العزيز لتطوير أساليب وتقنيات التعليم والتعلم والتي سيكون لها أثرا كبيرا في تطوير العملية التعليمية والبحثية.

وحيث أن الدراسة تعتمد على مرحلتين المرحلة الأولى تتضمن توزيع الإستبانة وتعبئتها و المرحلة الثانية يُطلب من نفس الطالبة إعادة تعبئة إستبانة أخرى مشابهة لمعرفة صدق البيانات وثباتها التي سيعتمد عليها البحث . لذا فإن كتابة الاسم ورقم الجوال والبريد الالكتروني والملاحظات لها أهمية كبرى وستستعمل للتواصل فقط. فلرجاء الاهتمام بتعبئتها. علماً بأن جميع الإجابات ستحاط بسرية تامة وسوف تستخدم لأغراض البحث العلمي فقط.

شاكرين حسن تعاونك وداعيه الله أن يلهمنا جميعاً الصواب للوصول لحلول تساعد على أفضل الأساليب في التحصيل العلمي.

أ.نهله محمد الجوجو

مديرة وحدة تقنية المعلومات بكلية اقتصاد وإدارة

القسم الأول: معلومات شخصية

الرجاء ملئ البيانات التالية:

الاسم	
الرقم الجامعي	
الكلية	
القسم	
العمر	
البريد الإلكتروني	

أرغب في الحصول على نتيجة التشخيص ☐ نعم ☐ لا

القسم الثاني: مقياس أساليب التعلم

الرجاء اختيار إجابة واحدة فقط لكل سؤال من الأسئلة التالية. إذا كانت كلا الإجابتين تنطبق عليك فضلاً اختر الإجابة التي تنطبق عليك أغلب الوقت.

١ - أفهم الشيء بعد أن
(أ) أجربه.
(ب) أفكر فيه جيداً .

٢ - أفضل أن يُنظَر إلي كشخص
(أ) واقعي.
(ب) مبتكر.

٣ - عندما أفكر فيما فعلته بالأمس، فإن الاحتمال الأكبر أن استرجعه في شكل
(أ) صورة.

(ب) كلمات.

٤ -أميل إلى
(أ) فهم التفاصيل في موضوع ما ولكن الموضوع ككل قد يكون غير واضح .
(ب) فهم الموضوع ككل ولكن التفاصيل قد تكون غير واضحة.

٥ -عندما أتعلم شيئاً جديداً، يساعدني ذلك في
(أ) التحدث عنه.
(ب) التفكير فيه .

٦ -لو كنت مدرساً فإني أفضل تدريس مقرر
(أ) يتعامل مع الحقائق ومواقف واقعية من الحياة (مثل مادة الفيزياء أو مادة الكيمياء).
(ب) يتعامل مع الأفكار والنظريات(مثل الاقتصاد أو علم اجتماع).

٧ -أفضل الحصول على معلومات جديدة في شكل
(أ) صور، مخططات بيانية، رسومات بيانية أو خرائط
(ب) تعليمات مكتوبة أو معلومات شفوية .

٨ -بمجرد أن أفهم
(أ) كل أجزاء الموضوع، افهم الموضوع بأكمله.
(ب) الموضوع بأكمله، أرى علاقة وترابط أجزاء الموضوع مع بعضها البعض.

٩ -إذا كنت ضمن مجموعة دراسية تقوم بأداء مهمة ما في مادة صعبة، الأرجح
(أ) أن أتدخل وأشارك بالأفكار.
(ب) أن أجلس و استمع.

١٠ -أجد أنه من السهل
(أ) تعلم الحقائق (الحقيقة هي معلوما ت أو أحداث عرفت بأنها قد حصلت أو تمت. مثل حدوث الحرب العالمية الأولى أو الحرب العالمية الثانية).
(ب)تعلم المفاهيم (المفهوم هو فكره عامه استخلصت من أحداث معينة أو فكرة تكونت في الذهن عن شيء ما. مثل مفهوم السعادة – مفهوم الحرية) .

١١ -في الكتاب الذي يحتوي على كثير من الصور والمخططات، الأرجح أن
(أ) أفحص الصور والمخططات بعناية.

(ب) أركز على النص المكتوب.

١٢ -عندما أحل مسائل حسابية

(أ) عادة ما أتوصل إلى الحلول خطوه بخطوه أو(تدريجيا).

(ب) غالباً ما أرى الحلول ثم بعد ذلك أكافح للتوصل للخطوات المؤدية إلى تلك الحلول.

١٣ -في بعض المواد التي درستها

(أ) استطعت التعرف على كثير من الطلبة .

(ب) في النادر ما أتعرف على الكثير من الطلبة.

١٤ -عند قراءتي مواضيع واقعية فإني أفضل أن أقرأ عن شيء

(أ) يعلمني حقائق جديدة أو يبين لي كيفية عمل شيء ما .

(ب) يعطيني أفكار جديدة للتفكير بها.

١٥ -أحب المدرسين

(أ) الذين يضعون كثيراً من الرسومات والمخططات التوضيحية على السبورة.

(ب) الذين يقضون وقتاً كثيراً في الشرح .

١٦ – عند تحليل قصة أو رواية قرأتها

(أ) أفكر في أحداث القصة وأحاول أن أجمعها حتى أفهم معنى القصة أو(مغزى القصة).

(ب) عندما انتهي من قراءة القصة أعرف المعنى أو(المغزى) ثم أعود إلى القصة وأبحث عن الأحداث والمواقف التي تثبت المعنى الذي فهمته.

١٧–عندما أبدأ في حل مسائل الواجب، الأرجح أن

(أ) أبدأ بحل المسألة فوراً.

(ب) أحاول فهم المسألة جيدا ثم أبدأ بحلها.

١٨– أفضل مبدأ

(أ) الحقيقة (الحقيقة هي معلومات أو أحداث عرفت بأنها قد حصلت أو تمت. مثل الحرب العالمية الأولى أو الحرب العالمية الثانية أو حقيقة علمية مثل أن الأرض كروية).

(ب) النظرية(مجموعة من الأفكار التي تعتمد على البرهان والتفسير المنطقي والتي يتم من خلالها معرفة كيفية عمل الأشياء وسبب حدوثها ولكن لم يكتمل إثباتها بصفة متكاملة. مثل نظرية فيثاغورث أو النظرية النسبية... نظريات الذكاء أو النظريات الإجتماعية).

١٩- أتذكر أفضل

(أ) الأشياء التي أراها.
(ب) الأشياء التي اسمعها.

٢٠ – من المهم لي بدرجة كبيرة أن يقوم المعلم

(أ) بعرض المادة في خطوات متسلسلة وواضحة .
(ب) بتزويدي بصورة شاملة عن المادة وربطها بمواضيع أخرى.

٢١- أفضل الدراسة

(أ) في مجموعة دراسية.
(ب) بمفردي.

٢٢- من الأرجح أن ينظر إلي كشخص

(أ) يهتم بالتفاصيل أثناء أدائي لعملي .
(ب) يبتكر طرقاً مختلفة للقيام بالعمل.

٢٣- عندما يوصف لي طريقة الوصول لمكان جديد، أفضل

(أ) الخريطة.
(ب) التعليمات المكتوبة.

٢٤ – أنا أتعلم

(أ) بطريقة منتظمة ومرتبة (إذا درست واجتهدت سأفهم الموضوع).
(ب) بطريقة غير منتظمة ومتقطعة وغير مرتبة(أكون مشوشة في البداية وفجأة يتضح الموضوع أمامي).

٢٥- أفضل أولاً أن

(أ) أجرب الأشياء.
(ب) أفكر كيف سأقوم بها.

٢٦- عندما أقرأ للتسلية ، أحب من الكاتب أن

(أ) يذكر ما يقصده بشكل واضح.
(ب) يذكر الأشياء بطرق مبتكرة وشيقة .

٢٧ – عندما أرى مخططاً بيانياً أو رسماً توضيحياً في الفصل ، فالأرجح أن أتذكر

(أ) الصورة.
(ب) ما قاله المعلم بخصوصها.

٢٨- عند النظر في قدر من المعلومات، فالأغلب أني

(أ) أركز على التفاصيل وأنسى الصورة الكاملة للمعلومات.
(ب) أحاول فهم الصورة الكاملة قبل الدخول في التفاصيل.

٢٩- أتذكر بسهولة أكثر

(أ) شيء قمت بفعله.
(ب) شيء فكرت فيه كثيراً.
٣٠ – عندما يتعين علي القيام بمهمة ما، أفضل أن

(أ) أتقن طريقة واحدة للقيام بها.

(ب) أبتكر طرقاً جديدة للقيام بها.

٣١-عندما يعرض علي شخص ما بعض البيانات، أفضل أن تكون على شكل

(أ) المخططات أو الرسومات البيانية.
(ب) تلخيص نصي للنتائج.

٣٢- عندما أكتب بحثا فإنني على الأغلب أن

(أ) أعمل (أفكر بشأن أو اكتب) على البحث من البداية ثم أنتقل إلى الأجزاء المتتالية بالترتيب.
(ب) أعمل (أفكر بشأن أو أكتب) في الأجزاء المختلفة من البحث ثم أقوم بترتيبها.

٣٣- عندما أعمل أتولى العمل في مشروع جماعي فإني أود في البدء

(أ) بعصف ذهني جماعي حيث يشارك الجميع بأفكارهم.
(ب) بعصف ذهني بشكل منفرد ثم اللقاء كمجموعة لمقارنة الأفكار.

٣٤- عندما أُبالغ في مدح شخص يكون مدحي له بأنه شخص

(أ) عقلاني أو واقعي .
(ب) واسع الخيال.

٣٥ – عندما أقابل أشخاصاً في حفلة، فمن الأرجح أن أتذكر

(أ) أشكالهم والهيئة التي كانوا عليها.
(ب) ما قالوه هم عن أنفسهم.

٣٦- عندما أتعلم موضوعاً جديداً، أفضل أن

(أ) أركز في نفس الموضوع لأتعلم أكبر قدر ممكن عنه.
(ب) أحاول أن أربط بين ذلك الموضوع والمواضيع ذات الصلة.

٣٧- – الأرجح أن ينظر إلى على أنني شخص

(أ) ودي
(ب) هادئ أو منطوي.

٣٨- أفضل المقررات التي تركز على

(أ) مادة ملموسة (حقائق وبيانات مثل مادة الفيزياء أو الكيمياء).
(ب) مادة تجريدية (مفاهيم ونظريات مثل مادة علم النفس أو علم الإجتماع).

٣٩ – للتسلية أفضل

(أ) مشاهدة التلفزيون.
(ب) قراءة كتاب.

٤٠- بعض المدرسين يقومون بإعطاء فكرة مختصرة عن موضوع المحاضرة قبل شرحها ، أنا اعتبر هذه الفكرة المختصرة :

(أ) مفيدة لي إلى حد ما.
(ب) مفيدة لي بشكل كبير.

٤١- فكرة أداء الواجبات ضمن مجموعة بحيث تعطى نفس الدرجة لكل فرد ضمن المجموعة

(أ) تعجبني.
(ب) لا تعجبني.

٤٢- عندما أقوم بحسابات طويلة

(أ) أميل لمراجعة خطوات الحل والتأكد من عملي بدقة.
(ب) أجد مراجعتي لخطوات الحل مُرهِقاً ولكن أجبر نفسي على مراجعته.

٤٣- أميل إلى تذكر صورة الأماكن التي زرتها

(أ) بشكل سهل ودقيق إلى حد ما .
(ب) بصعوبة وبدون أي تفاصيل

٤٤- عند حل مسائل مع مجموعة فإنني على الأغلب

(أ) أكون ممن يفكرون في الخطوات الخاصة بعملية الحل.
(ب) أكون ممن يفكرون في النتائج المترتبة أو التطبيقات المحتملة للحل في مجموعة واسعة من المجالات.

ملاحظات

الرجاء إبداء أي ملاحظات أو تعليقات لك سواء على الأسئلة أو الإجابة أو الاستبيان ككل

شاكرين لك تعاونك

Appendix B: Questionnaires Evolutions of course

B1: First Questionnaire of evaluation student in Arabic

فضلا أجيبي عن الأسئلة التالية ثم انتقلي للاجابه على الاختبار

العباره	نعم	لا
١) درست المادة من الموقع الخاص بأساليب التعلم		
٢) استخدمت الشرائح الخاصة بأسلوبي		
٣) استخدمت شرائح صديقتي		
٤) المادة بهذه الطريقة سهله وواضحة		
٥) أتمنى ان تستخدم بقية الأساتذة أسلوبا مشابها لنستفيد بطريقة نفضلها		
٦) المعلومات واضحة وسهله		
٧) من السهولة أن ادرس بنفسي بهذه الطريقة		
٨) هناك العديد من النقاط التي لم افهمها		
٩) أفضل أن تشرح الأستاذة المادة العلمية		
١٠) استفادتي كانت ممتازة		
١١) استفادتي كانت ضئيلة		
١٢) لم افهم محتوى المادة العلمية لصعوبته		
١٣) اعتقد أنها تجربه ممتازة		

١٤) كيف ممكن أن تساعدك في العميلة التعليمية ؟

_____

١٥) هل وجدت بعض الأخطاء في المحتوى وأين ؟

_____

١٦) اذكري مثالا لتلك الأخطاء إن وجدت ؟

_____

١٧) مدى استفادتك من هذه التجربة ؟

_____

١٨) تقيمك للتجربة بشكل عام

_____

B2: **First Questionnaire of evaluation student in English**

Please answer the following questions and then start answering the quiz:

Statements	YES	No
1. I learned the material from the site related to learning styles (www.adaptivelearningstyle.com)		
2. I used the learning style that belongs to me		
3. I used my friend's learning styles		
4. The material in this manner is easy and clear		
5. I hope the rest of the professors use a similar method of teaching so we can learn in a way that we prefer		
6. Information is clear and easy		
7. It's easier to teach myself that way		
8. There are a number of points I didn't understand		
9. I prefer that the professor explain material related to my study		
10. I learned a great deal		
11. I didn't learn much		
12. I did not understand the contents of the subject related to science because it was difficult		
13. I think it's a great experience.		

14. How can it help in your educational process?
15. Did you come across any mistakes in the content and where?
16. Please point any mistake if available?
17. How much did you learn from this experience?
18. How do you evaluate this experience?

B3: **Teacher`s Questionnaire of evaluation in Arabic**

استمارة رقم {١}

استبانة تقييم

معلومات شخصية

الرجاء ملئ البيانات التالية:

الاسم	
التخصص	
الكلية	
سنوات الخبرة	

١ –المواد التي تدرسينها

_____

٢ –الصعوبات التي تواجهك في تدريس مادة الإحصاء

_____

٣ –أساليب تطوير طريقة التدريس

_____

اختاري إجابة واحدة فقط					
الرقم	السؤال	الاختيارات			
4	**لدى ..... باستخدام الحاسب الآلي؟**	معرفة بدرجة كبيره	معرفة بدرجة متوسطه	معرفة ضئيلة	ليس لدي معرفة
5	**لدي سابقة باستخدام الانترنت ؟**	معرفة بدرجة كبيره	معرفة بدرجة متوسطه	معرفة ضئيلة	ليس لدي معرفة
6	**يمكننى الدخول وتصفح الموقع الخاص بالمادة التعليمية من .....(www.adaptivelearningstyle.com)**	المنزل	الجامعة	أخرى اذكريها	
7	**الدخول على الموقع الخاص بالمادة التعليمية وتصفحه بالنسبة لى (www.adaptivelearningstyle.com)**	سهل جدا	سهل	سهل إلى حد ما	غير سهل
8	**كان عرض المادة التعليمية على الانترنت بالنسبة لك**	واضح لدرجة كبيره	واضح لدرجة متوسطه	واضح نسبيا	غير واضح
9	**كان عرض المادة التعليمية على الانترنت بطريقة**	شيقة و واضحة	شيقة وغير واضحة	واضحة وغير شيقة	غير واضحة وغير شيقة
10	**كان عرض الأمثلة .....**	شيقة و واضحة	شيقة وغير واضحة	واضحة وغير شيقة	غير واضحة وغير شيقة
11	**عرض المادة بهذه الطريقة سهل لي فهم المادة**	أوافق جدا	أوافق	أوافق إلى حد ما	لا أوافق
12	**اعتقد إن استخدام التقنية في التعليم يجعله أكثر سهوله**	أوافق جدا	أوافق	أوافق إلى حد ما	لا أوافق

اختاري أكثر من إجابة								
الرقم	السؤال	الاختيارات						
13	**افضل ..... في عرض المادة التعليمة**	النص	الرسومات توضيحية	الشرائح	الأمثله	التمارين	الاختبارات ذاتيه	الفيديو	الصوت
14	**افضل استخدام .....** **.....عند تصفح المادة التعليمية**	زر الأمام – زر الخلف	زر التنقل من صفحه لصفحه أخرى	زر الرجوع للصفحة الرئيسية	زر الطباعة	فهرس المادة التعليمية (التنقل من فصل للفصل آخر أو من موضوع لموضوع آخر)			
15	**افضل استخدام .....للتواصل مع طالباتي**	المحادثة	المنتديات	التلفون	المقابلة وجها لوجه	البريد الكتروني			أخرى اذكريها

ملاحظات

الرجاء إبداء أي ملاحظات أو تعليقات على الموقع الخاص بالمادة التعليمية

شاكرين لك تعاونك

B4: Teacher`s Questionnaire of evaluation in English

Personal Information

Name	
Major	
Faculty	
Years of experience	

1) Subjects you are studying

_____

2) Problems you have while studying Statistics

_____

3) How to improve teaching?

_____

Chose one answer only				
Questions	**Options**			
4) Do you have a background using the computer?	I know so much	sort of	a little	No idea
5) Do you have a background using the Internet?	I know so much	sort of	a little	No idea
6) Where can you enter and browse the site related to your study? www.adaptivelearningstyle.com	Home	University	Home and university	Other
7) Is entering and browsing the site related to your study? www.adaptivelearningstyle.com	So easy	Easy	Kind of easy	Not easy
8) Was showing the subject related to your study?	So easy	Easy	Kind of easy	Not easy
9) Showing the subject related to your study was interesting and clear?	Interesting and clear	Interesting and not clear	Clear and not Interesting	not Clear and not Interesting

10) The examples were…	Interesting and clear	Interesting and not clear	Clear and not interesting	Not Clear and not interesting
11) Showing the subject this way makes it easy to understand it?	Strongly agree	Agree	Don't agree much	Disagree
12) Do you think using technology in education makes it easier?	Strongly agree	Agree	Don't agree much	Disagree

You can chose more than one answer								
Questions	**Option**							
13) How would you like the subject to be shown?	Text	Pictures +graphics	Slideshow	Examples	Exercises	Self test	Video	Sound
14) Which of these buttons do you prefer to use when browsing the subject?	Forward/Back button	Jump button	Home page button	Print button	Tree of course Index (Going from one subject to another)			
15 Which of these tools do you prefer to use to communicate with the subject students?	Chat	Forum	Telephone	Personal interview		Other		

B5: Qualitative data of teachers' survey

Qualitative data were collected via the teacher`s survey (see Appendix B, Teachers' Evaluation Questionnaire .The questions were as follows:

1) Subjects you are studying

1- Statistics theory – Statistics maths and advanced maths
2- Statistics 111, Statistics 205, Individuals Insurance, research and training
3- Statistics 101 & 102/, psychological evaluation interpretations of Islamic behaviours/individual differences/and more
4- Psychology, introduction to psychological Statistics, psychology for distance students

2) Problems you have while studying Statistics

1- The basic information which students should know from previous studies is very poor. Some groups of students do not have the same level of education, which forces the professor to take more time to explain points they should have already known – certain subjects require more hours than that set aside for students.
2- No difficulties, students are not able to reach the right answer; maths is very hard, they do not know the basics of algebra and maths, such as algebra calculation, square roots, square number, double a number. Students do not know how to use a calculator.
3- Students are not able to concentrate in general.
4- The course is not long enough for distance students. Time is wasted in solving steps. There is not enough time for examples and exercises. There are not enough laboratories to teach students the SPSS programme. Students are not aware of maths fundamentals – there is a need to make information easy to understand, to solve a problem in short and easy steps and to explain the subject individually for those students who did not have the chance to attend the qualification course. Students are getting lost and unable to solve a problem when taking too long.

3) How can teaching be improved?

1- Concentrate to understand, competition, learning a subject from different angles, offer new ideas, encourage students to do researches and use different sources to get information. Train students to deal with new questions that have indirect ideas, avoid ordinary and repeated questions so students get used to thinking correctly and experience new situations related indirectly to what they study. Different choices, short, home style, simple, researches.
2- Using available programmes to apply the subject.
3- Using more than one way to explain.
4- Find researches, follow up on analysing results and tie to them the study information.
5- Using the PowerPoint in teaching.
6- Using Statistics films.
7- Provide students with documents containing the ideal answers, show the subject using the PowerPoint style and explain all steps necessary. Then, provide a student with a quiz to solve during class and another to solve at home.

B6: Second Questionnaire of evaluation student in Arabic

استمارة رقم {١}

استبانة تقييم

عزيزتي الطالبة

أشكرك على اقتطاع بعضاً من وقتك الثمين للإجابة على استبانه هذا البحث المقدم من الباحثة نهلة محمد الجوجو للحصول على درجة الدكتوراه في مجال نظم المعلومات، وتهدف هذه الاستبانة إلى تقييم موقع تكييف و تلائم المواد الدراسية وفقا للأساليب التعلم ، ولذا نأمل منك تحري الدقة في الإجابة على بنود الاستبانة باختيارك أقرب إجابة تعكس الواقع.

ومن أهداف البحث تحديد أفضل أساليب التعلم ثم تكييف المواد الدراسية وفقا للأساليب التعلم ، مما يضمن مخرجات تعليمية على درجة عالية من الكفاءة العلمية، ومما يضمن ثراء العملية البحثية ، التي تهدف إلى الوصول إلي أفضل الأساليب التعليمية، وبالتالي تقديم كوادر علمية قادرة على تطوير المجتمع. لذا فإن الملاحظات لها أهمية كبرى

وستستعمل للتواصل فقط. فلرجاء الاهتمام بتعبئتها. علماً بأن جميع الإجابات ستحاط بسرية تامة وسوف تستخدم لأغراض البحث العلمي فقط.

شاكرين حسن تعاونك وداعيه الله أن يلهمنا جميعاً الصواب للوصول لحلول تساعد على أفضل الأساليب في التحصيل العلمي.

نهله محمد الجوجو

مديرة وحدة تقنية المعلومات بكلية اقتصاد وإدارة

القسم الأول: معلومات شخصية

الرجاء ملئ البيانات التالية:

الاسم	
الرقم الجامعي	
الكلية	
القسم	
البريد الإلكتروني	
المعدل التراكمي	
درجتك في مادة الإحصاء المستوى العام	
درجتك في مادة الإحصاء المستوى الأول	
درجتك في مادة الإحصاء في النصفي لهذا المستوى	
درجتك في مادة الإحصاء في الدوري لهذا المستوى	

أحبيبي على الأسئلة التالية :

١ -هل استخدمت البرنامج على الويب سايت (www.adaptivelearningstyle.com) الخاص بالمادة التعليمية (مادة الإحصاء) ؟

---

٢ -كم مرة دخلت على الويب سايت (www.adaptivelearningstyle.com) الخاص بالمادة التعليمية (مادة الإحصاء) تقريبا ؟

---

٣ -ما هي الأجزاء التي ركزت عليها في دراستك عند دخولك الموقع؟(www.adaptivelearningstyle.com) الخاص بالمادة التعليمية (مادة الإحصاء)؟

---

٤ -هل تعتقدي أن البرنامج نجح في إيصال المعلومات الخاصة بمادة الاحصاء

---

٥ -هل تحتاجي إلي شرح إضافي بالنسبة للموضوع من قبل أستاذة المادة

---

٦ -ما هى المعوقات التي واجهتك في استخدام البرنامج ؟

٧- ما هو رأيك بالتفصيل في البرنامج ؟

اختاري إجابة واحدة فقط

الرقم	السؤال	الاختيارات			
٨	**لدى ..... باستخدام الحاسب الآلي**	معرفة بدرجة كبيره	معرفة بدرجة متوسطه	معرفة ضئيلة	ليس لدي معرفة
٩	**لدي ..... سابقة باستخدام الانترنت**	معرفة بدرجة كبيره	معرفة بدرجة متوسطه	معرفة ضئيلة	ليس لدي معرفة
١٠	**يمكنني الدخول وتصفح الموقع الخاص بالمادة التعليمية من ..... (www.adaptivelearningstyle.com)**	المنزل	الجامعة	أخرى (اذكريها)	
١١	**الدخول على الموقع الخاص بالمادة التعليمية وتصفحه بالنسبة لي ..... (www.adaptivelearningstyle.com)**	سهل جدا	سهل	سهل إلى حد ما	غير سهل
١٢	**كان عرض المادة التعليمية على الانترنت بالنسبة لك .**	واضح لدرجة كبيره	واضح لدرجة متوسطه	واضح نسبيا	غير واضح
١٣	**كان عرض المادة التعليمية على الانترنت بطريقة .**	شيقة و واضحة	شيقة وغير واضحة	واضحة وغير شيقة	غير واضحة وغير شيقة
١٤	**كان عرض الأمثلة بطريقة .**	شيقة و واضحة	شيقة وغير واضحة	واضحة وغير شيقة	غير واضحة وغير شيقة
١٥	**عرض المادة بهذه الطريقة سهل لي فهم المادة .**	أوافق جدا	أوافق	أوافق إلى حد ما	لا أوافق
١٦	**اعتقد إن استخدام التقنية في التعليم يجعله أكثر سهوله.**	أوافق جدا	أوافق	أوافق إلى حد ما	لا أوافق

اختاري أكثر من إجابة									
الرقم	السؤال	الاختيارات							
١٧	**أفضل ..... في عرض المادة التعليمة**	النص	الرسومات توضيحية	الشرائح	الأمثلة	التمارين	الاختبارات ذاتيه	الفيديو	الصوت
١٨	**أفضل استخدام .....** **.....عند تصفح المادة التعليمية**	زر الأمام – زر الخلف	زر التنقل من صفحه لصفحه أخرى	زر الرجوع للصفحة الرئيسية	زر الطباعة	فهرس المادة التعليمية (التنقل من فصل للفصل آخر أو من موضوع لموضوع آخر)			
١٩	**أفضل استخدام .....للتواصل مع أستاذة المادة**	المحادثة	المنتديات	التلفون	المقابلة وجها لوجه	البريد الكتروني		أخرى(اذكريها)	

ملاحظات

الرجاء إبداء أي ملاحظات أو تعليقات على الموقع الخاص بالمادة التعليمية

شاكرين لك تعاونك

B7: Second student evaluation questionnaire in English

Personal Information

Name:	
Student Number:	
Faculty:	
Major:	
Email Address:	
GPA	
Your Statistics Score, Overall Level:	
Your Statistics Score, First Level:	
Your Statistics Score for Mid Term in this Level:	

Please answer the following questions:

1) Did you use the programme available on the website (www.adaptivelearningstyle.com) related to this educational subject (Statistics)?

2) How many times did you visit the website (www.adaptivelearningstyle.com) related to this educational subject (Statistics) approximately?

3) Which parts did you focus on to help you study when you visited the website (www.adaptivelearningstyle.com) related to this educational subject (Statistics)?

4) Do you think that the programme was successful in explaining the information related to Statistics?

5) Do you still need a further explanation by a professor to help you understand?

6) What kind of problems did you have while using System (TASAM)?

7) What do you think about System (TASAM), in detail?

Choose one answer only				
Questions	**Options**			
8) DO you have a background on using the computer?	I know so much	Sort of	A little	No idea
9) Do you have a background on using the Internet?	I know so much	Sort of	A little	No idea
10) Where can you enter and browse the site related to your study? www.adaptivelearningstyle.com	Home	University	Home & university	Other
11) Is entering and browsing the site related to your study? ww.adaptivelearningstyle.com	So easy	Easy	Kind of easy	Not easy
12) Was showing the subject related to your study?	So easy	Easy	Kind of easy	Not easy
13) Was showing the subject related to your study interesting and clear?	Interesting and clear	Interesting and not clear	Clear and not interesting	Not clear and not interesting
14) The examples were?	Interesting and clear	Interesting and not clear	Clear and not interesting	Not clear and not interesting
15) Showing the subject in this way makes it easy to understand?	Strongly agree	Agree	Don't agree much	Disagree
16) Do you think using technology in education makes it easier?	Strongly agree	Agree	Don't agree much	Disagree

You can chose moreone answer								
Questions	**Option**							
17) How would you like the subject shown?	Text	Pictures +graphics	Slide show	Examples	Exercises	Self test	Video	sound
18) Which of these buttons do you prefer to use when browsing the subject?	Forward/Backward button)	Jump button	Home page button	Print button	Tree of course Index (Going from one subject to another)			
19) Which of these tools do you prefer to use to communicate with the subject teacher?	Chat	Forum	Telephone	Personal interview		Other		

B8: Qualitative Data of students' survey

Qualitative data were collected via the students' survey (see appendix B, Questionnaire of evaluation students. The questions are as follows:

1) Did you use the programme available on the website (www.adaptivelearningstyle.com) related to this educational subject (Statistics)?

   All students said yes.

2) How many times did you visit the website (www.adaptivelearningstyle.com) related to this educational subject (Statistics) approximately?

   3-10 times approximately.

3) Which parts did you focus on to help you study when you visited the website (www.adaptivelearningstyle.com) related to this educational subject (Statistics)?

   Examples, self test, exercises.

4) Do you think that the programme was successful in explaining the information related to Statistics?

   Yes.

5) Do you still need a further explanation by a professor to help you understand?

   Few students said yes.

6) What kind of problems did you have while using System (TASAM)?

Appendix C. Additional Information on Project Materials

C1: Learning Content Structure of Three Lessons of First level of 221 Statistics Behaviour

الفصل الرابع: مقاييس النزعة المركزية	
اولاً:المتوسط الحسابي	تعريف المتوسط الحسابي
	حالات المتوسط الحسابي
	عينة صغيرة
	عينة متوسطة
	عينة كبيرة
ثانيا: الوسيط (الأوسط)	تعريف الوسيط
	حالات الوسيط
	عدد أفراد العينة فردي و صغير
	عدد أفراد العينة صغير و زوجي
	عدد أفراد العينة كبير و منظم في جدول تكراري
ثالثا: المنوال (الشائع	تعريف المنوال
	حالات المنوال
	العينة الصغيرة
	الجدول التكراري
رابعا: العلاقة بين مقاييس النزعة المركزية	

<table>
<tr><td colspan="2">الفصل الخامس : مقاييس التشتت</td></tr>
<tr><td>التعريف بمقاييس التشتت و أهميتها</td><td></td></tr>
<tr><td rowspan="3">أولا: المدى</td><td>البيانات الغير المبوبة</td></tr>
<tr><td>المدى من جدول تكراري</td></tr>
<tr><td>بيانات غير مبوبة</td></tr>
<tr><td rowspan="2">ثانيا: الانحراف المعياري</td><td>البيانات المبوبة باستخدام مجموع مربعات الانحراف</td></tr>
<tr><td>البيانات المبوبة(الجدول التكراري) باستخدام الانحراف الافتراضي</td></tr>
<tr><td>ثالثا: التباين</td><td></td></tr>
<tr><td>رابعا: المدى الربيعي و نصف المدى الربيعي</td><td></td></tr>
<tr><td>خامسا: الارباعيات</td><td></td></tr>
<tr><td>سادسا: المئينيات والأعشاريات</td><td></td></tr>
<tr><td colspan="2">الفصل الثامن: أساليب حساب العلاقة بين متغيرين أو أكثر ودلالتها الإحصائية</td></tr>
<tr><td colspan="2">المقدمة</td></tr>
<tr><td colspan="2">أولا: معامل ارتباط بيرسون</td></tr>
<tr><td colspan="2">ثانيا: معامل ارتباط سبيرمان</td></tr>
</table>

ثالثا: معامل الاقتران الرباعي
رابعا: معامل ارتباط فاي
خامسا: معامل الاغتراب و معامل التحديد
سادسا: معامل الارتباط الجزئي

C2: Learning Content Structure of Three Lessons of First level of 222 Statistics Behaviour

الفصل العاشر: اختبار ت لحساب الفروق بين العينات و دلالاتها الإحصائية
تعريف اختبار ت
شروط اختبار ت
قانون الالتواء
اختبار التجانس (ف) للعينات
استخدام اختبار ت
حالات اختبار ت
الحالة الأولى : للعينات الغير المستقلة (المرتبطة)
حالات متوسطي عينتين مستقلتين
الحالة الثانية: لمتوسطي عينتين مستقلتين
الحالة الثالثة: لمتوسطي عينتين مستقلتين

Appendix D. Tutorial of Teacher Assisting and Subject Adaptive Material system

خطوات تعبئة الاستبيان الخاص بأساليب التعلم أون لاين(عن طريق الانترنت)

١. نفتح المتصفح (الانترنت اكسبلور)

٢. نكتب في شريط عنوان المتصفح (الانترنت اكسبلور) عنوان الموقع التالي (www.adaptivelearningstyle.com) كما هو موضح بالشكل ١

شكل :1

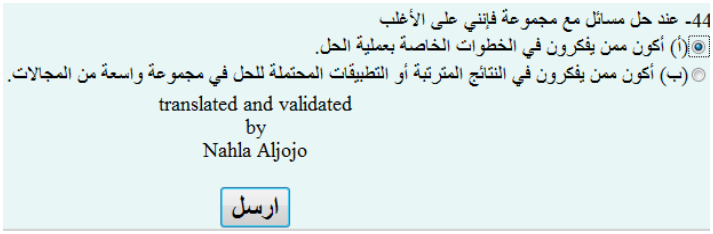
٣. إذا كنت مستخدم جديد ولم يسبق لك ملأ الاستبيان اون لاين من قبل اضغط على زر (مستخدم جديد) كما هو موضح بالشكل ٢

شكل : ٢

٤. قم بتعبئة الاستبيان الخاص بأساليب التعلم كما هو موضح بالشكل ٣

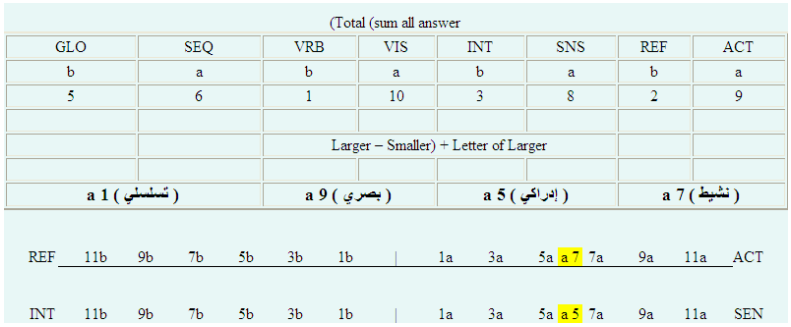
شكل: ٣

٥. بعد الانتهاء من ملأ الاستبيان كاملا(٤٤ سؤال) اضغط على زر إرسال كما هو موضح بالشكل ٤



شكل: ٤

٦. بعد الضغط على زر إرسال سوف تظهر لك أساليب التعلم الخاصة بك كما هو موضح بالشكل ٥، لكل طالبه أربعه أساليب تعلم.



شكل: ٥

<u>لمعرفة المزيد عن أساليب في التعليم</u>

١. اضغط على زر (الرئيسية) كما هو موضح بالشكل ٦

شكل: ٦

٢. اضغط على زر (مساعدة) لمعرفة المزيد عن أساليب التعليم كما هو موضح بالشكل ٧

شكل ٧

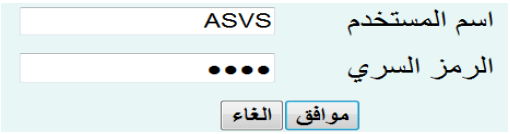
<u>خطوات استعراض المنهج الخاص بمادة الإحصاء الوصفي والاستدلالي حسب أساليب التعلم الخاص بكل طالبه</u>

<u>ملاحظة</u> : لابد من ملأ الاستبيان قبل استعراض المنهج الخاص بمادة الإحصاء الوصفي والاستدلالي

١. إذا كنت قد قمت بتعبئة الاستبيان في الموقع سابقا اضغط على زر (تسجيل الدخول) كما هو موضح بالشكل ٨

شكل:٨

٢. قم بإدخال اسم المستخدم و الرقم السري الذي استخدمته عند ملأ الاستبيان سابقا ثم اضغط على زر موافق كما هو موضح بالشكل٩



شكل:٩

٣. ثم اضغط على زر (ملف الطالب) فإذا كان اسم المستخدم والرقم السري صحيح تظهر لك رسالة تم التسجيل بنجاح كما هو موضح في الشكل ١٠.

شكل:١٠

4. اضغط على زر (دروس) حتى تظهر لك الدروس مقابله للنمط التعلم الخاص بك التي قد تمت تعبئتها في الفقرة الرابعة كما هو موضح في الشكل ١١

ملاحظة: نمط التعلم هو نتيجة للاستبيان التي قد تمت تعبئتها في الفقرة الرابعة.

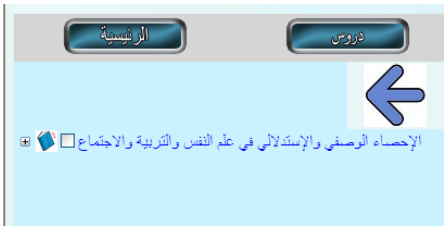
شكل:١١

٥. اضغط على زر (اختار) للمنهج المطلوب الخاص بمادة الإحصاء الوصفي والاستدلالي كما هو موضح في الشكل ١٢

اختار	المنهج	الوصف
اختار	مبادئ الإحصاء للتخصصات النظرية	إحصاء 115
اختار	الإحصاء الوصفي والإستدلالي في علم النفس والتربية والاجتماع	الإحصاء الوصفي والإستدلالي في علم النفس والتربية والاجتماع

شكل:١٢

٧. ثم اضغط على إشارة (+) لعرض محتويات المنهج كما هو موضح في الشكل ١٣.

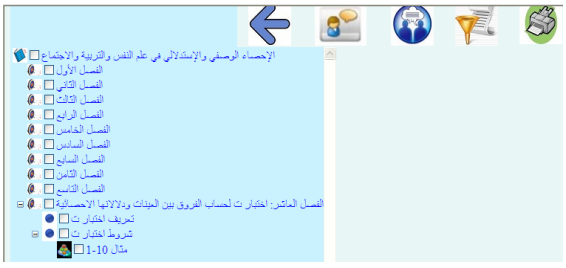


شكل:١٣

٨. اختار ما تريد دراسته أو معرفته من اختبار(ت) فمثلا إذا أردت معرفة تعريف اختبار (ت) فاضغط على هذا الموضوع أو العنوان تعريف اختبار (ت) كما هو موضح في الشكل ١٤ .

شكل:١٤

٩- إذا أردت عرض أي فصل من الفصول أو طباعته فعليك اختيار الفصل المراد طباعته أو عرضه أولا ثم الضغط على زر طباعة فيظهر لك الفصل كامل على شكل شرائح PowerPoint فيمكنك تخزين الملف في الجهاز الخاص بك أو طباعته كما هو موضح بالشكل ١٥



الشكل ١٥

١٠ – إذا أردت عرض أي تمرين من تمارين الفصل أو طباعته فعليك اختيار االتمرين المراد طباعته أو عرضه أولا عن طريق الضغط على اسم التمرين بالماوس ثم الضغط على زر طباعة الموجود في الموقع فيظهر لك االتمرين كامل على شكل ملف PDF فيمكنك تخزين الملف في الجهاز الخاص بك أو طباعته كما هو موضح بالشكل ""

١١- إذا أردت عمل إختبار ذاتي حتى تتأكد من أنك قد فهمت الدرس جيدا في نهاية كل فصل يوجد اختبار ذاتي يمكنك القيام بحل هذا الاختبار وفي نهاية هذا الاختبار يقوم النظام بإعطاك نتيجة هذا الاختبار والدرجه التي حصلت عليها.

Appendix E: Overall research methodology and actual design/process

Overall design	Actual design/process
Literature review	Literature review and review previous works covering adaptive learning systems. There are many learning style theories used today and the learning style theories have been applied widely in educational environments from preschool to postgraduate and across cultures. For example, the Theory into Practice Database (Kinshuk and Lin,2003) provides 50 major theories of learning and instruction, such as Kolb's learning style theory (Kolb, 1984), Gardner's Multiple Intelligences Theory (Gardner, 1993), Felder-Silverman Learning Style Theory (Felder and Silverman, 1988; Felder, 1993), Litzinger and Osif Theory of Learning Styles (Litzinger and Osif,1993; Kinshuk and Lin,2003), Myers-Briggs Type Indicator (MBTI) (Briggs and Myers, 1977; Myers and McCaulley, 1985). Many educational systems that adapt to learning styles have been developed, including the system developed by Carver et al. (1999), the Arthur system (Gilbert & Han, 1999), MASPLANG (Peña, Marzo, & de la Rosa, 2002; Peña, 2004), LSAS (Bajraktarevic et al., 2003), INSPIRE (Papanikolaou et al., 2003), TANGOW (Paredes & Rodriguez 2004) and the system AHA! created by (Cristea, & de Bra,2006). Currently, many researchers agree on the importance of modelling and using leaning styles. However, there is little agreement on aspects of learning style worth modelling, and what can be done differently for users with different styles (Brusilovsky, 2001. See Chapter Two).
Choosing an appropriate learning style measurement instrument	Felder-Silverman Learning Style Theory (LST) categorises an individual's preferred learning style by a sliding scale of five dimensions: sensing-intuitive, visual-verbal, inductive-deductive, active-reflective and sequential-global (Felder and Silverman, 1988; Felder, 1993). Currently, the inductive-deductive dimension has been deleted from the previous theory, because of pedagogical reasons (namely, it is deemed less useful for representing hypermedia courseware). The Felder-Silverman LST is chosen to be implemented in this research for the following reasons: • Its Index of Learning Style (ILS) questionnaire (Felder and Soloman, 2003) provides a convenient and practical approach to establish the dominant learning style of each student. • The results of ILS can be linked easily to adaptive environments (Paredes and Rodriguez, 2002). • It is most appropriate and feasible to be implemented for hypermedia courseware (Carver, et al., 1999; Kinshuk and Lin, 2003), which is the overall aim of the research project.
Instrument validity and reliability	Validity and Reliability are mainly covered in Aljojo et al. (2009) and Aljojo and Adams (2009), though section 3 provides some background to learning styles and adaptive systems. The Felder and Soloman Index of Learning Styles (ILS) instrument was selected for this study and the translation and conversion process into Arabic consisted of forward then backward translation by independent English-Arabic translators. The resulting Arabic version of the ILS was then evaluated, question by question, by a panel of eight Arabic and English speaking psychologists to ensure consistency of constructs. The final Arabic version of the ILS was applied to just 1204 Arabic speaking undergraduate students and the

	results checked for internal consistency and construct validity in line with English versions of the ILS (Aljojo and Adams 2010).
Create the initial system (TASAM)	Sixteen types of learning styles and their corresponding implementation rules have been finalised. Following the experimental work applied by Carver In (Car, 1999) and using a similar approach that takes advantage of versatility offered by teaching the tools of MASPLANG environment, the teaching content and navigation tools to match learning styles have been adapted. Adapting some traditional instructional strategies and building the learning object by means of HTML pages, which have subjects embedded in different media format Tables 5.4, 5.5, offers a useful distribution of criteria for selecting the right instructional strategies, media format and navigation tools for adaptive presentation. As can be seen in Tables 7 and 8 instructional strategies, media format and navigation tools proposed could cater for almost all learning styles. In any case, the main reason for identifying the components previously is to be able to offer the learning content and the learning environment that best fits the learning profile obtained from the ILS questionnaire.
Develop the system (TASAM)	Develop an adaptive teaching taxonomy mapping out electronic media representations of teaching material with learning styles and the teaching strategy for the course(s) (mainly covered in Aljojo and Adams, 2010), though section 3. An adaptive teaching taxonomy that ties up learning styles with teaching strategy and electronic media, is the basis of any adaptive learning system based around individual learning styles. The taxonomy in table 3 tries to represent the different learning styles, with teaching strategies, suggesting suitable electronic media to represent and access learning material. This taxonomy has been constructed based on an evaluation of Soloman-Felder learning style theory and usage of e-media. It also builds on previous work, such as Franzoni et al. (2008), which used an expert panel adopting the Delphi method held during the III Congreso de Estilos de Aprendizaje at Cáceres (Spain) in July 2008.
Trial test the system(TASAM)	Participants consisted of 80 students from Arts and Humanities Faculty and organised into three different groups: a) students using the TASAM system with no professor explanation of the topic; b) students using the TASAM system with professor explanation of the topic; and c) students not using the TASAM system and only using the professor explanation of the topic (mainly covered in Aljojo and Adams , 2010)
Initial evaluation and assessment of the adaptive learning system by students and tutors	The evaluation questionnaire was answered by four teachers who used the TASAM teaching environment. Overall, teachers seemed to have enjoyed using the TASAM system and there seemed to have been a positive impact on learning performance. The evaluation questionnaire was also answered by 32 students, who used the TASAM teaching environment (see table 12). (mainly covered in Aljojo and Adams , 2010)
Develop the system (TASAM)	Global scale does not find any appropriate teaching strategy for it, so for the students with a global learning style preference, pages comprised elements such as a table of contents, summary, diagrams, overview of information and jump from page to page, etc. For sequential students, the pages contained small chunks of information, text-only pages with 'forward' and 'back' buttons.

Final test system (TASAM) in first semester (2011)	1- Compared the result of group (A) using the TASAM system without professor explanation of the chapter Correlation with students of group (A) not using the TASAM system only using the professor explanation of the chapter (Measures of Central tendency). 2- Compared the exam result of group (A) using the TASAM system without professor explanation of the chapter Measures of Variability with students of group (A) using the TASAM system with professor explanation of the chapter (Measures of Variability). 3- Compared the exam result of group (A) students using the TASAM system without professor explanation of the chapter ((Measures of Variability) with second group (B) students using the TASAM system without professor explanation of the chapter (Measures of Variability). 4- Compared the exam result of group(A) students not using the TASAM system without professor explanation of the chapter (Measures of Variability) with second group (B) students using the TASAM system with professor explanation of the chapter (Measures of Variability). 5- Compared the result of group(B) using the TASAM system without professor explanation of the chapter Measures of Central tendency with students of group(B) not using the TASAM system only using the professor explanation of the chapter (Correlation). 6- Compared the exam result of group (B) using the TASAM system without professor explanation of the chapter Measures of Variability with students of group (B) using the TASAM system with professor explanation of the chapter (Measures of Variability).
Final evaluation and assessment of the adaptive learning system by students and tutors	Questionnaire of first student evaluation was answered by 112 students who learned the material from the site related to learning styles (www.adaptivelearningstyle.com). Questionnaire of second evaluation student was answered by 110 students who used the TASAM teaching environment.
Final test system (TASAM) in the second semester (2011)	Group (A) using the TASAM system with no professor explanation of the chapters Measures of Central tendency and Measures of Variability (after adaptive) will learn significantly better than students of group (A) not using the TASAM system only using the professor explanation of the chapter (correlation) (before adaptive).
Final evaluation and assessment of the adaptive learning system by students and tutors in the second semester (2011)	Questionnaire of first student evaluation was answered by 54 students, who learned the material from the site related to learning styles (www.adaptivelearningstyle.com)

Appendix F: A screenshot of a lesson for leaning style

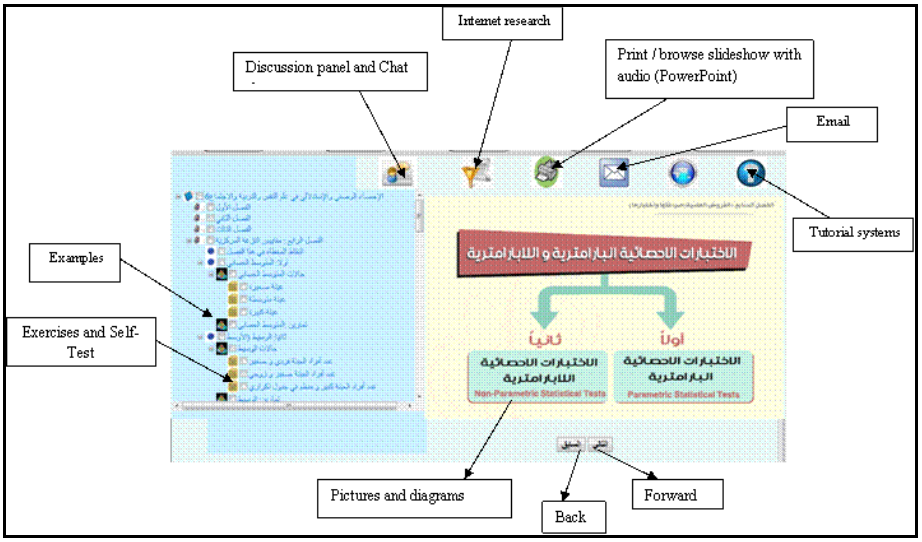


Figure F.1: A screenshot of a lesson for leaning style active/intuitive/visual/sequential

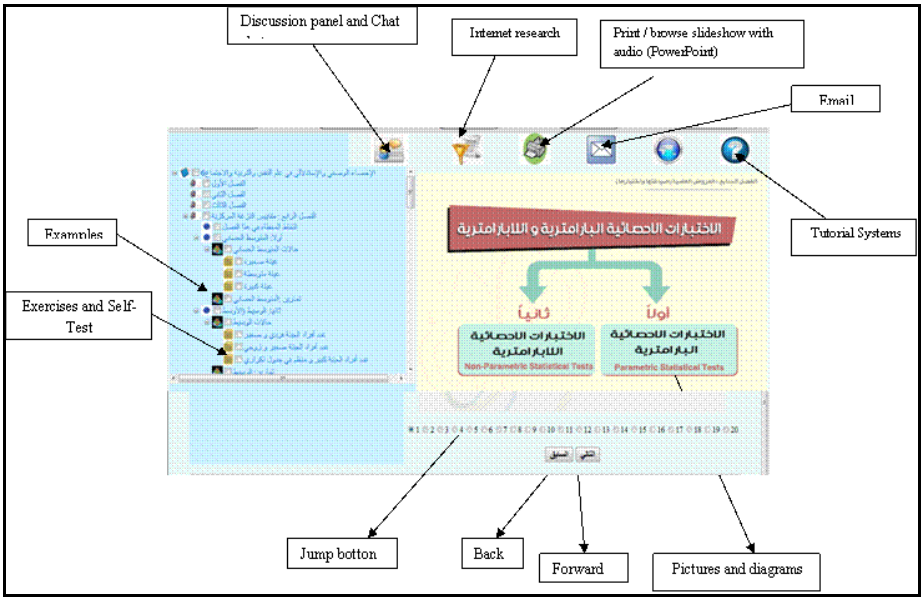


Figure F. 2: A screenshot of a lesson for leaning style active/intuitive/visual/global

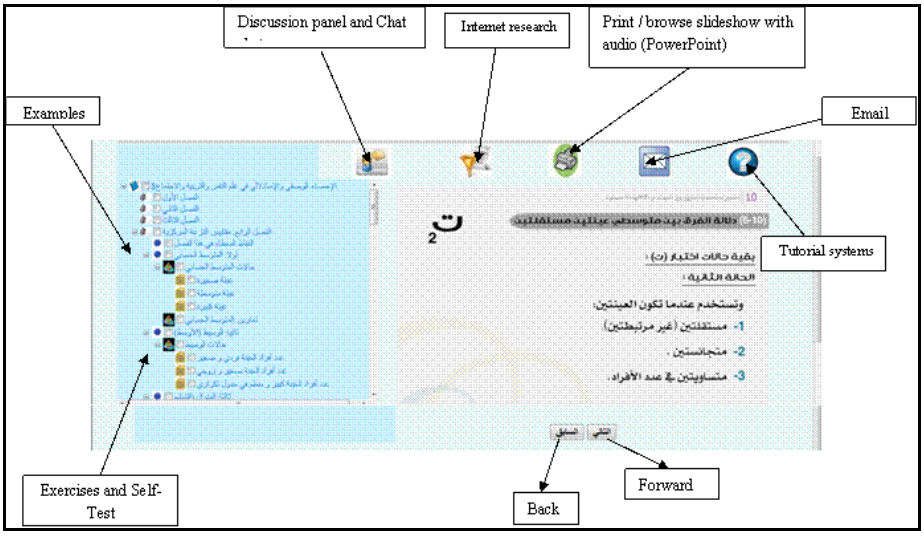


Figure F. 3: A screenshot of a lesson for leaning style active/intuitive/verbal/ sequential

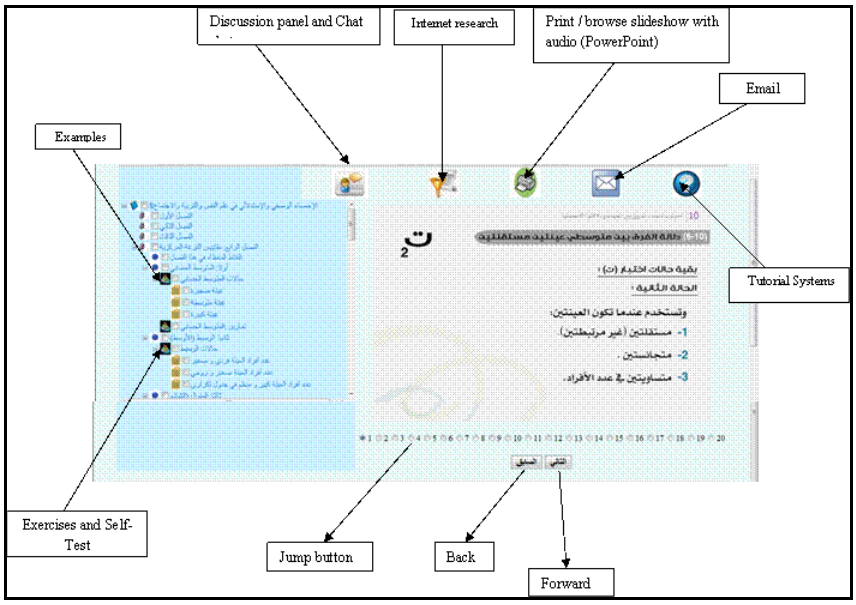


Figure F. 4: A screenshot of a lesson for leaning style active/intuitive/verbal/global

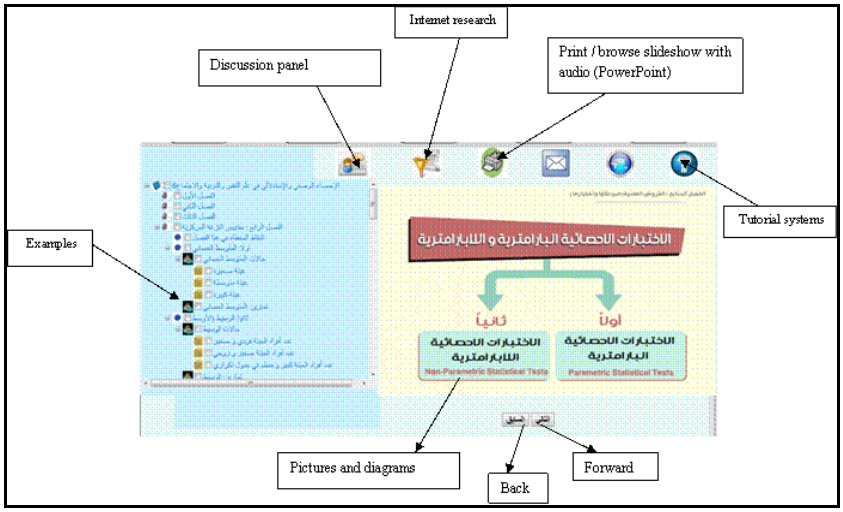


Figure F.5: A screenshot of a lesson for leaning style reflective/intuitive/visual/sequential

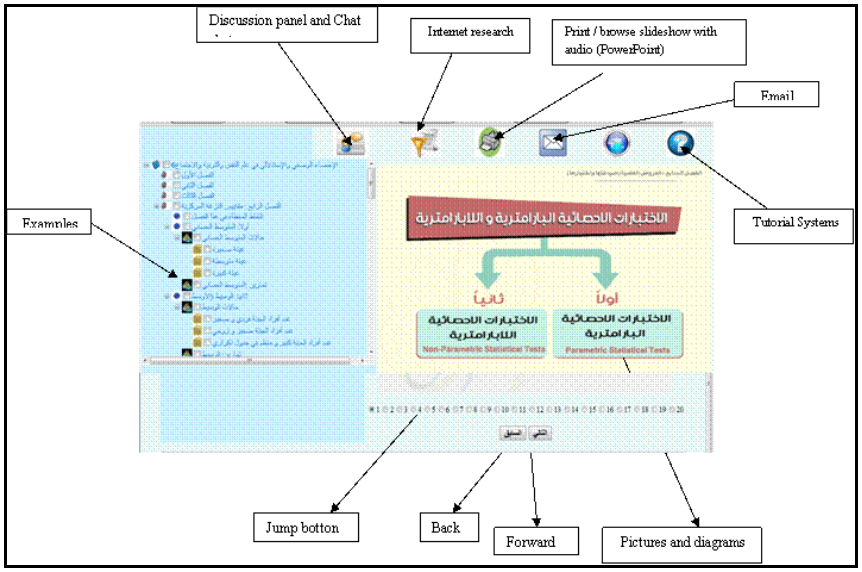


Figure F.6: A screenshot of a lesson for leaning style reflective/intuitive/visual/global

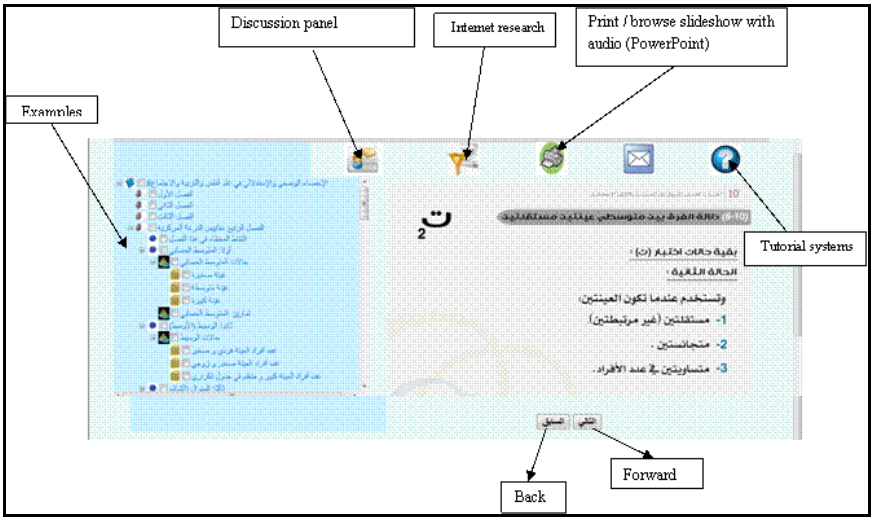


Figure F. 7: A screenshot of a lesson for leaning style reflective/intuitive/verbal/ sequential

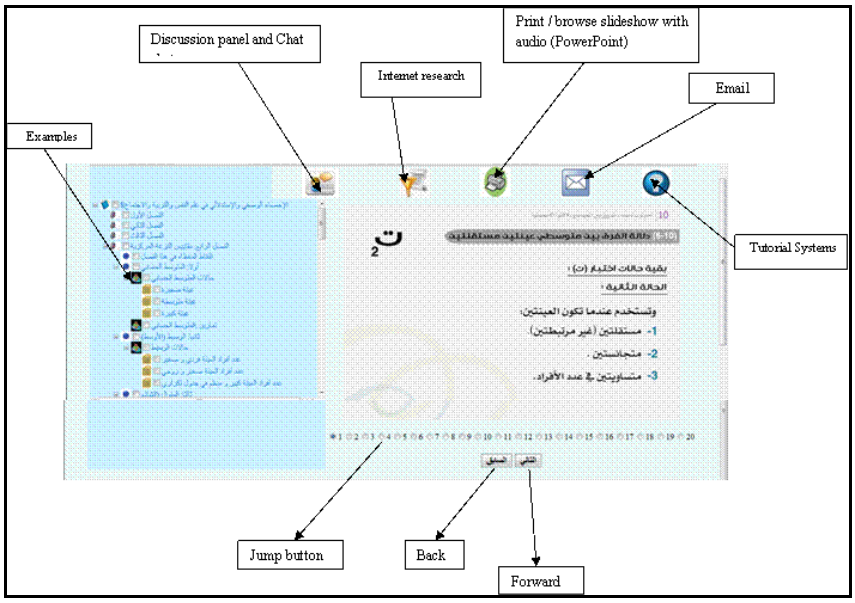


Figure F. 8: A screenshot of a lesson for leaning style reflective/intuitive/verbal/ global

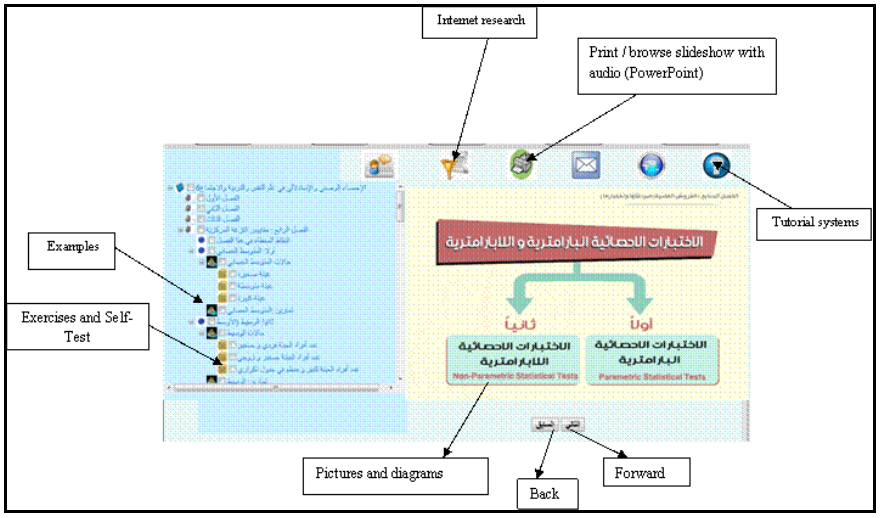


Figure F.9: A screenshot of a lesson for leaning style reflective/sensing/visual/ sequential

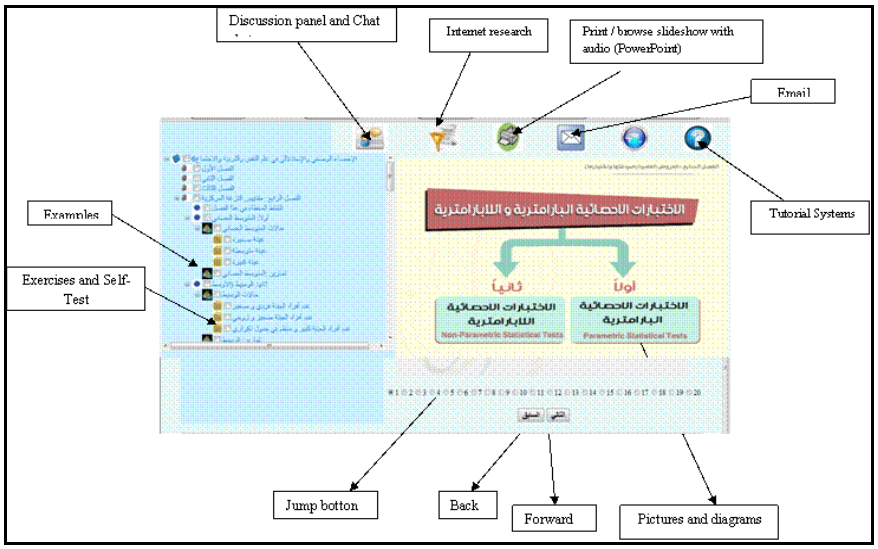


Figure F.10: A screenshot of a lesson for leaning style reflective/sensing/visual/global

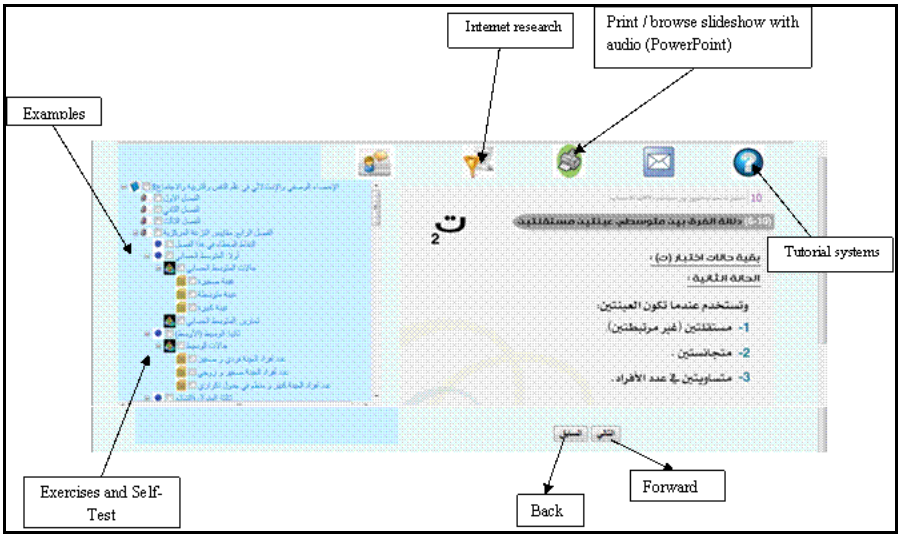


Figure F.11: A screenshot of a lesson for leaning style reflective/sensing/verbal/ sequential

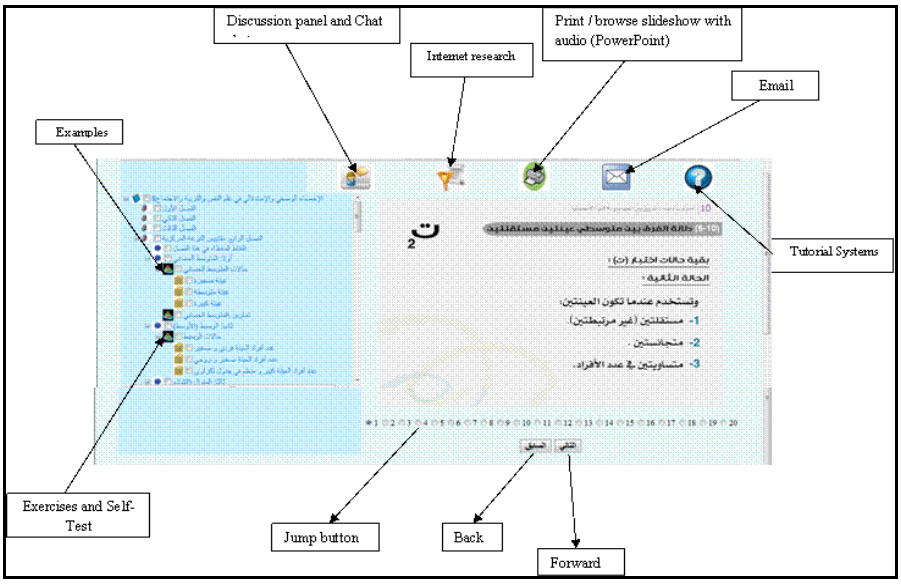


Figure F.12: A screenshot of a lesson for leaning style reflective/sensing/verbal/ global