Interactive Learning Systems for Higher Education: Learning Styles and Students’ Attitude

This thesis is submitted for the Degree of
Doctor of Philosophy

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May 2005
Abstract

This dissertation reports research concerning the adaptation of learning systems to students' different learning styles (LSs), particularly in relation to the analysis and planning of Interactive Learning Systems (ILSs). Given the primacy of Interactive Learning and its pedagogical implication on educational designs, the motivation for this research is better understanding of students' different learning preferences and perceptions of Computer Mediated Learning Interactions (CMLIs), as this may present some insights into what and how interactivity can be incorporated more purposefully and efficiently into learning systems designs. This research undertakes a review of the literature relating to LSs' theories, which have been used to explore how individual learners approach learning, as well as different Learning Interactions in relation to Interactive Learning Systems (ILSs). The work undertaken in this research makes its contribution to the field in that it represents one of the first explicit investigations of the relationship between students' LSs (Active-Reflective/Visual Verbal dimensions) and their attitude towards different CMLIs that constitute essential part of ILSs, in terms of use, perceptions and learning preferences, from the users' (learners) perspective rather than the teachers and/or designers of these systems. The research provides evidence to support the differing views of learners of different LSs as well as evidence of common attitudes towards certain CMLIs. However, it warns against and highlights some of the limitations of using the LSs in isolation and the importance of considering other factors and aspects of students' individual differences. A model is proposed to guide the planning and design of ILSs, and to raise the designers' and teachers' awareness of learners' differences and call upon them to take necessary steps to consider actual learners' LSs in the learning design. Implications of the findings in terms of interactivity design considerations are discussed; research limitations and recommendations for future work are made.
Publication Note


Acknowledgements

Firstly, I would like to thank and acknowledge the guidance given by my first supervisor Dr Lynne Baldwin and my second supervisor Professor Robert Macredie throughout the four years of my research. Secondly, I would like to thank all students took part in this research and made this research possible.

Thirdly, I would like to thank Dr Chris Evans, Dr Sarmad Al-Shawi, Professor Guy Fitzgerald, Dr Tony Elliman for the support I received at different stages of my research, and Professor Ray Paul for his seven research seminars that provided valuable guidance for conducting my research.

Finally, I would like to thank all my family for their patience and continuous support throughout my PhD research journey.
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Glossary of Terms

AR  Active-Reflective dimension of Learning Styles
CML  Computer Mediated Learning (see also e-learning)
CMLIs  Computer Mediated Learning Interactions
E-learning  Electronic learning (see also CML)
F2F  Face-to-Face
HE  Higher Education
ILSs  Interactive Learning Systems
LI  Learning Interaction
LSs  Learning Styles
NVC  Non-Voluntary Choice (of using CMLIs)
S-I  Student-Information Interaction
S-S  Student-Student Interaction
S-T  Student-Tutor Interaction
TDLE  Traditionally Dominated Learning Environment
TLIs  Traditional Learning Interactions
WBL  Web Based Learning
WBLIs  Web Based Learning Interactions
VC  Voluntary Choice (of using CMLIs)
VDLE  Virtually Dominated Learning Environment
VLEs  Virtual Learning Environments
VV  Visual-Verbal dimension of Learning Styles
3-CMLIs  Three- Computer Mediated Learning Interactions
3-WMI  Three Way Model of Interactivity
Chapter 1- Introduction

1.1 Background

Higher education (HE) institutions are seeking to produce Web-based learning (WBL) materials as a way of helping learners whose number, needs and backgrounds vary enormously in today's HE climate, to learn and as a way to solve some of the problems facing much of traditional on-campus learning such as lack of interactivity, adaptation, and not allowing for reflection or promoting a sense of community and collaboration (Jones et al, 1999; Laurillard, 1993). Web technology, which can form an important component of interactive learning, is increasingly used for learning interaction (Horton, 2000; Nielsen NetRatings, 2002; McGraw-Hill, 2002), becoming commonplace in education institutions (Whittington and Campbell, 1998; Collis et al, 2000), and beginning to have an impact on them (Fitzgibbon and Jones, 2004). According to a survey conducted by McGraw-Hill (2002), 56% of academic staff in colleges and universities use the Web to supplement textbooks, and 51% use it to ensure up-to-date course content. According to the Department for Education and Skills (DFES), it has the potential to revolutionise the way we teach and how we learn (DFES, 2003). Some of these advantages are related to increased control and adaptivity over time, place, and pace of study, suiting individual differences, encouraging reflection and interaction (Wulf, 1996). Others include helping in the opening up of new possibilities for the support of synchronous and asynchronous approaches to teaching and learning (Barker, 1999; Berge, 1999; Shotsberger, 1997), and increasing interactivity (Evans et al, 2002). Interactive learning systems (ILSs) have many advantages over their counterparts in that they can develop more positive learning attitudes (Najjar, 1998), boost learning (Horton, 2000), provide intrinsic feedback on the actions of the learner (Laurillard, 2002), and provide different types of interactions, along with shaping and linking material and activities in different ways to suit different types of learners (Graham et al, 2000).

However, while WBL can be used effectively in HE, there are many pitfalls that need to be considered and carefully monitored by instructors (Thomas, 2000), some of which can be related to emotional absorption and social isolation (Bates, 1995) and lack of interactivity (Sims, 1999; Nelson, 1990). Usually learning programmes that are offered via the Web are technically driven rather than pedagogically (Carswell, 1998) and very often only positive
aspects of computer-mediated education are emphasised, and the kind of work it requires for students and faculty are understated (Kling and Hara, 2000). Horton (2000) also notes a word of caution, that WBL does not change the way humans learn, but can change the way they are taught or the way the learning material is delivered. Furthermore, the mechanisms for learning interactions using WBL or CML (Computer-mediated Learning) are less known due to the newness of the media (Nicol et al, 2003). Mason (1998a) adds that the increasing diversity of educational opportunity through the use of the Web will lead to the growth of new educational roles. Bates and Leary (2001) also note that such technologies are not mere artifacts whose use is self-evident, but they are open to interpretation that can have influence on both thinking and use (Schreiber and Berge, 1998). Having said that, most early attempts tend to just dump the learning material online (Horton, 2000), and it is dangerous to assume that just by replacing traditional teaching techniques with new technologies a significant improvement will be achieved (Dede, 1996; Moore 1996). According to a survey conducted in July 2002 (ETV, 2002) almost two thirds rated WBL as either 'fair' or 'poor', only a third rated it as 'good', 5% rated it as 'very good', and only 1% rated it as excellent. If, as these figures suggest, learners do not rate WBL highly, this would seem to raise issues about the design of the learning systems that learners use, particularly, in relation to its adaptation to different students needs and consequently influencing its interactivity design.

However, the design and implementation of interactivity, as an essential and often ignored component of learning systems, can be complex and cumbersome, requiring skills and knowledge from across disciplines including, among others, software engineering, human computer interaction (HCI), learning theories and cognitive psychology. Designing effective learning systems requires looking at several variables and considerations; including interactivity and interactions design (Graham et al, 2001). The idea of interactive learning can be found in much literature on learning (Cohen, 1994; Slavin, 1994), however there seem to be no consensus of what it really involves (Street and Goodman, 1998), the degree and type of interaction vary according to learning theory practices, and without investigating students' learning preferences it is difficult to develop. Furthermore, for learning systems to be interactive for different types of learners, it will be vital to take account of the users (the learners) who are expected to use such systems for learning. According to Bates and Leary (2001), it is not enough to give students access to appropriate tools and learning environments, but these should also provide appropriate support for students' differences. Research on Individual difference allows educators to bring the system to the user (learner) rather than the reverse (Borgman, 1995). This is essential because, people are different and perceive the world in different ways; learn in different ways and under different conditions.
(Birkey and Rodman, 1995). On the other hand, most learning happens 'independently' and people consider they learn best at their own pace, at times and places of their own choosing, often with other people around (especially fellow learners), and when they feel in control of their learning (Race, 1994).

Despite the growing interest in considering the learners, their different needs and requirements for learning systems design, the primary focus of literature related to integrating technology in HE focuses in most cases on organisational (Ehrmann, 1995; Gilbert, 1996) and technological aspects (Green, 1996). However, in recent years, considerable interest has emphasised the centrality of the learner in the learning process. This is indicated by Bates (1995) who notes that three significant developments could be observed: the move to multimedia, and enabling a wider range of educational applications of computers; the use of computer networks for communication purposes; and a change in philosophy, from computers as teaching machines, to computers as tools that not only can empower teachers but also can accommodate different learners. Furthermore, Edwards (1995) describes technological-mediated knowledge as being an active and a more effective way of providing individualised learning and accommodate wide variety of learners needs. Horton (2000) also adds that WBL accommodates many different styles of learning (through using visual or verbal; analytical or experiential ways) and different individuals' preferences (such as morning or evening studying; extroverts or introverts). It also allow for different types of Computer-Mediated Learning Interactions (CMLIs) including learner-content where the learner interacts with course content or related information, learner-instructor where the learner interact with experts, and learner-learner where the learner interacts with other learners (Moore, 1989; Hillman et al, 1994; Moore and Kearsley, 1996).

CMLIs can give a range of choices, not just restricted to total teacher-led or total student-led approaches, but one which gives different degrees of involvement between these two extremes (Horton, 2000). This can help enable the development of learning strategies that are sensitive to student differences and accommodate such diverse student populations (Birkey and Rodman, 1995). Some further consider the learners in terms of their learning styles (LSs) and individual differences (Honey and Mumford, 1992; Ford and Miller, 1996; Leader and Klein, 1996), use of computers and the Web for learning (Driscoll, 1998; McCormack and Jones, 1998; Graham et al, 2000; Horton, 2000; Daniel, 1998), and understanding the link between design and different types of learners (Miller, 2004; Wilson, 1999; Chen and Ford, 1998; Chen and Macredie, 2002). Taking into consideration that students' differences in perceptions, personalities and backgrounds are of vital importance (Collis et al, 2000), some
elements of these differences have been addressed. For example, Collis's "4-E model" (Collis et al, 2000), argues that an individual's likelihood of using such technologies in teaching or learning (assuming a voluntary choice is involved) can be expressed in terms of four groups of factors: perceived Educational Effectiveness, personal Ease of use, Engagement and Environment (where the 4th 'E' depends on influences related to one's educational organisation, social environment and perception of technology push in daily life). The TAM (Technology Acceptance Model) by Davis (1989) and Davis et al (1989), argued that three main factors may help in predicting computer use, including perceived usefulness, perceived ease of use, and intention to use. DeBello (1985) also emphasises that when students are taught using approaches and resources that complement their LSs preferences, their achievements are significantly improved. Having said that, LSs are often ignored in the design and delivery of instruction (Birkey and Rodman, 1995), particularly in terms of the pedagogical issues of WBL (Windschitl, 1998), interactivity design, and the direct relationship between learners' attitude towards CMLIs and the diversity of students, particularly in relation to students' LSs.

However, the complexity of human learning and the diversity of learning tasks make it difficult to find "universal generalizations" that can be applied to all instructional objectives, all learners, and all learning conditions (Lumsdaine, 1996, p79). Learners use different learning strategies (Riding and Rayner, 1998), perceive and process information in different ways (Felder, 1993) and consequently develop different patterns of behaviour that they are most comfortable with, which are more commonly referred to as their LSs. For example, Felder and Silverman (1988) categorise learning styles into four dimensions, two of which are, the Active-Reflective and Visual-Verbal dimensions that are particularly relevant to the interactivity of learning systems in terms of information processing and perception of sensory information. Where Active students prefer active engagement in the learning process, Reflective students prefer learning through introspection, Visual students prefer learning through use of visual elements, and Verbal students prefer to use of textual elements. Such variations and diversifications if not diagnosed and accommodated at early stages, can result not only in student dropout (Westera et al, 2000) but also can make designing learning systems a more complicated task as it requires accommodating a wider range of characteristics (Galitz, 2002), and for these to be interactive, certain qualities and principles should be closely related to different learners' needs.
1.2 Research focus and objectives

Despite the extent of the literature in the field of LSs, and the consensus that learners learn in different ways and that instructors and course designers need to take this into account, there still exist some interrelated problems that face designers and teachers, and require further attention:

- One, the lack of existing knowledge of students' perception of CMLIs usefulness in relation to their LSs, extent to which students will be willing to use them, and rarely do educators focus on the important issue of 'what' in relation to students' attitude towards different CMLIs. Would different students' LSs affect students' attitude towards using CMLIs? For example, how would Active students who prefer active engagement in the learning process perceive different types of CMLIs in comparison with Reflective students who prefer learning through introspection? How would Visual students who prefer learning through use of visual elements perceive different types of S-I presentations in comparison with Verbal students who prefer to use of textual elements?

- Two, the extent to which the styles exhibited should be considered as fixed for a particular population of learners.

- Three, few studies have directly addressed the problem of learning systems that adapt to some of learners' individual differences (Chen and Ford, 1997), and consequently the absence of design guidelines, models, or frameworks, that are closely related to the learner, in relation to CMLIs for the ILS.

- Four, the extent to which the styles exhibited should be accommodated, and the extent to which the weak or non-exhibited styles should be considered in the ILS design.

- Five, what should interactivity encompass in terms of its definition and characteristics in relation to actual learners' differences (LSs) from an ILS perspective?

Therefore it can be beneficial to understand what students' LSs are, and how to address them when preparing instructional materials. An important advantage for the teacher or designer of ILSs is to be aware of the degree of diversity of LSs in the student population in order to guide the development of appropriate and relevant instructional strategies and frameworks for ILSs. Similarly, it is equally important to consider the subject requirements, kind of knowledge involved, learning goals and skills to be developed. For example, whether active and/or reflective skills; high and/or low level of engagement (Biggs, 1999) in order to determine the levels and types of learning interactions required. The scope of this research does not include investigation of students' performance or learning outcomes, but instead
looks at students' use, perceptions and preferences in relation to different CML interactions. By doing so, it aims to improve the interactivity design and consequently layout a suitable ground for improving learning outcome. Some research has shown positive results on student's learning outcome when the learner is able to use their preferred learning method (Campbell and Campbell, 1999). After all, performance is a result of many factors some of which are tangible and some are not easy to measure. Whilst learning interactions do not necessarily have direct effect on student’s performance, they seem to have positive effect on student attitude towards their learning (Kearsley, 1995; Fulford and Zhang, 1993). This study adopts Rieber's (2001) view that the design should not only be concerned with students' learning performance, but also with their attitude and feelings towards learning interactions.

Further, this study is neither an attempt to design Web based courses nor to investigate in depth cognitive issues related to students' personal learning preferences. This study investigates learners' attitudes towards CMLIs in relation to their LSs. It is concerned with the user (the learner) as the core focus of any effective learning system design. The focus is on understanding the student's LS as one of the factors that have an effect on student's learning behaviour, and as a prerequisite for developing Interactive Learning Systems (ILSs). It focuses on the understanding of students' differences and their implications for the design of ILSs, particularly in terms of students' 'use' and 'perception' of the 3-CMLIs: S-I (Student-Information), S-S (Student-Student), and S-T (Student-Tutor). Consequently, that may help in determining the interactivity level of an ILS and its effect on a student attitude and degree of acceptance of the learning system.

To recap, this study will try to find out whether students with different/similar LSs have different/similar attitudes towards using and perceiving CMLIs. For example, how would Active students who prefer active engagement in the learning process perceive different types of CMLIs in comparison with Reflective students who prefer learning through introspection? How would Visual students who prefer learning through use of visual elements perceive different types of S-I presentations in comparison with Verbal students who prefer the use of textual elements? It will seek to test the validity of the hypotheses that, the student's LS may be associated with student's attitude towards the use of 3-CMLIs, and explore students' perception, and learning preferences (conceptual form of hypothesis-see Figure 1.1). In other words, it hypothesises that some students with particular LSs are more prepared to use CMLIs than others. Consequently, it examines whether LSs can be used as predictors of students' preference and perception of different types of CMLIs as a prerequisite for developing adaptive and adaptable ILSs.
By doing so, this research intends to build on and extend the understanding about students' differences in relation to the 'interactivity' concept of learning systems. By examining different variables of students' differences and learning preferences through the investigation and exploration of possible links between LSs and students attitude towards CMLIs, this study aims to establish a knowledge base that may contribute to the interactivity and adaptation of learning systems, and help to predict the way learning systems should be designed and evaluated. This can help in determining a closer count of the ratio and/or the balance between different types of interactions required (for example, asynchronous, synchronous, student-led and tutor-led approaches) and between traditional and CML. This study has therefore five main objectives:

- One, undertake a review of the literature relating to LSs' theories, to explore how individual learners approach learning, and different types of CMLIs in relation to Interactive Learning Systems (ILSs).
- Two, examine and explore the LSs profile of students.
- Three, examine and explore possible common attitudes towards the 3-CMLIs for different LSs, in terms of use, perception and learning preferences.
- Four, identify and discuss possible implications of the findings on the ILS design, in terms of possible interactivity design considerations and the proposal of a model to support its adaptation and interactivity.
- Five, re-visit the 'interactivity' concept in the light of the reviewed literature and research findings, in relation to ILSs and LSs.

1.3 Summary and overview of dissertation chapters

Students' differences and their learning preferences are fundamental considerations to the planning and design of any learning system. That is how interactive and usable the system can be designed to adapt to student's differences and actual needs. Examining different variables
of students' differences and learning preferences can contribute to the interactivity and adaptation of learning systems, help to predict the way modules of study should be designed around CML, determine evaluation criteria for such systems, and the required ratio between different types of learning interactions including: S-I, S-T, S-S, asynchronous, synchronous, student-led and tutor-led approaches, and between traditional and CML. Consequently it aims to contribute to the effectiveness and efficiency of an ILS design within the context of the student's LS and its relationship to the use of different CML interactions, and considers the implications for its interactivity design. It hopes to open an academic platform on essential elements of ILSs and how they can be viewed in the light of students' individual differences namely LSs. It also hopes to create a useful base of empirical research in relation to LSs theory that consequently may contribute to the development of more comprehensive interactivity guidelines, model and framework that assist and guide the planning and design of an ILS.

The organisation of the remaining chapters of this dissertation is as follows:

Chapter 2 presents a review of research in the area of students' LSs and learning systems. It looks particularly at the need to consider the user of learning systems (the student) as an essential factor of an interactive learning system design, and argues that little attention has been given to students' different LSs in planning such designs, and raises research questions that will be investigated in this study. It reviews a range of literature from general aspects of interactive learning, learning preferences, and information systems to specific aspects of LSs and CMLIs. The review helps in identifying the components of ILSs to overcome the lack of clarity surrounding such systems, and explores the two concepts under investigation in this study, namely 'Computer-mediate Learning Interaction' (CMLI) and Learning Style (LS). Work done that links both LSs and CML is presented, and some gaps, questions and problems in relation to the ILS design are identified.

Chapter 3 discusses the research design to be used to answer the research questions. It presents details of the approach and methodology to be used in the study, in addition to the rationale behind its use. It explains and discusses the arguments behind the planning of the research phases, including a description and details of the questionnaires/ observation plan, details about the instrument to be used to measure students' different LSs and description of the population of learners used.
Chapter 4 presents the results of the main stage of the research (phase one), which is concerned with students' attitude towards CMLIs (voluntary based choice). It includes three successive survey questionnaires distributed to three study levels including undergraduate levels one and two (L1 and L2), and postgraduate students (ML) taking computer related degrees. The surveys include two main sections, one includes the Index of LSs questionnaire which will be analysed using a scoring sheet and the other includes a self-report questionnaire to find out student perception and preference of different CMLIs. A profile of students' LSs for each level is then drawn out in addition to their perception of CMLIs, and comparisons between them are made.

Chapter 5 presents the secondary stage of the study (phase two) of the research and results, which is concerned with examining students' attitude in two specific application based settings (involving non-voluntary based choice of CMLIs). The first is a lab setting, which incorporates a cross-sectional survey, small-scale, and built around the index of learning style instrument, and a self-reported questionnaire. This is to look for links between student's Visual-Verbal LSs and their attitude towards the two different contents presentations (S-I). The second setting is concerned with students' attitude towards using WebCT learning interactions. It includes a cross-sectional, small-scale survey (built around the index of learning style instrument, and a self-reported questionnaire), and observation.

Chapter 6 looks at both Phase 1 and 2 results in terms of students Active-Reflective LSs and/or Visual-Verbal profile and strength level of each style, attitude towards the 3 different types of CMLIs and comparison between them, and comparison between the two phases in terms of voluntary and non-voluntary choice of CMLIs. This chapter discusses the findings in terms of the literature review, association between LSs and students' use of the 3 types of CMLIs, common attitudes towards the 3-CMLIs, students' preferences towards using and learning different contents presentations (S-I), and students' degree of access to WebCT learning environment (S-S and S-T interactions). It concludes with the possible implications of the findings on ILSs design in terms of design considerations and models to guide them.

Chapter 7 spells out the contribution of this study throughout its sections. It discusses the findings in relation to the literature, aims and objectives of this research, and possible implications on the interactivity of learning systems design. The dissertation concludes with a discussion of the research limitations, recommendations and further educational research.
Chapter 2- Interactive Learning Systems and Learning Styles

2.1 Introduction

Designing interactive systems is a complex task as it requires knowledge from different areas and disciplines. Adding to the complexity is learning itself, learners’ individual differences, their different learning preferences and learning styles. The complexity of human learning and the diversity of learning tasks make it difficult to find a universal design that can be applied to all instructional goals, all learners, and all learning conditions (Lumsdaine, 1996). Designing an effective learning system requires looking at several variables and considerations; including interactivity and interactions design (Graham et al, 2000). For a learning system to be interactive for different types of learners, it will be vital to take account of the users (the learners) who are expected to use such systems for learning, and it is not merely enough to give students access to different tools and/or learning environments (Bates and Leary, 2001). It requires a move from a teacher-centred approach to a student-centred approach that focuses on the learner and gives students greater autonomy and control over learning choices they make such as learning methods and pace of study (Gibbs, 1992). This essentially requires investigation of factors such as learners’ different learning preferences, needs, interests, prior knowledge, experiences, background, talents and abilities. Further, the focus should be on the best available knowledge about learning, how it occurs and the effective ways for achieving it for the learners. Learner-centred pedagogy should be based on the learner’s needs rather than the teacher or the institution’s needs and should be compatible with the use of information and communication technology especially those that promote the teacher as a facilitator (Tam, 2000).

Adding to the complexity is the use of technology. Technology per se does not improve learning (Alexander and McKenzie, 1998; Clark, 1983) or learning satisfaction (Alexander and Boud, 2001; Irons et al, 2002). However the developments of learning systems in general have been driven by the technology itself rather than the understanding of how it can be applied effectively and efficiently for learning (Alexander and Boud, 2001). According to Hase and Ellis (2001), the challenge is about moving from teacher-controlled to learner-controlled learning rather than moving from traditional to non-traditional learning, and as
indicated by Salmon (2002), greater interaction and learners' participation are keys for active and interactive online teaching and learning. There is a gap between designers and teachers' understanding of how people can best learn online and the way courses are designed; and there is still much to be learnt about how to get the best out of such an evolving medium (Foley and Schuck, 1998; Hase and Ellis, 2001), and to understand how ICT can be used effectively for learning (Taylor, 2004). The instructional design should not only be concerned with delivering information to learner, but also with the efficient way information is presented (Mayer, 2001) and the way learning interactions (Moore and Kearsley, 1996) are designed to engage the learner. Accommodating individual differences is one of the pedagogical dimensions of CML (Reeves, 1997) and the knowledge of the different learning styles (LSs) can help developing more effective learning systems (Montgomery, 1995). A learning environment which is considered as a “space where resources, time, and reasons are available to a group of people to nurture, support, and value their learning of a limited set of information and ideas” (Rieber, 2001, p.3), should be treated with some caution, as there are limits to each learning environment both in “what can be learned” and “whose learning will be supported most” and that the complexity of human learning makes it difficult to identify “which learning resources are appropriate for which people” (pp3-4).

This chapter presents a review on research in the focus area of interactive learning systems (ILSs) and students' LSs. It firstly (section 2.2) explores some of the general concepts related to interactivity and learning including Interactive Learning and Learning preferences that may help identifying and highlighting areas of concern and/or influential factors that may have implications on the interactivity design of learning systems with emphasis on HE. It reviews literature on interactivity definitions and characteristics; learners' learning preferences and learning styles; and learning models. It then (sections 2.3 and 2.4) reviews literature on work done on computer systems and CML that relates to interactivity in order to explore interactivity characteristics and practices; models related to the user and use of technology; structure of learning systems and CMLIs; and possible gaps that needs further investigation and exploration.

2.2 Interactive learning and learning preferences

2.2.1 Definitions and characteristics

The terms interactivity and interaction are widely used in education, but there appears to be no consensus of what they really involve (Street and Goodman, 1998). Interactivity can be considered as a “fundamental mechanism for knowledge acquisition and the development of
both cognitive and physical skills" (Barker, 1994, p1) as our knowledge of the world is constructed through our interaction with it (Piaget, 1970). However, there is a widespread consensus among educators, teachers, and psychologists (Collins et al, 1989) that advanced skills of reasoning, comprehension, composition, and experimentation are acquired not only by the transmission of knowledge but also by the learner's interaction with content. Furthermore, Grabinger (1996) listed some of the major changes in our assumptions about learning, which included that learners are active constructors of knowledge rather than receivers of knowledge.

Adding to the complexity of the term interactivity and its characteristics, its connection to learning makes it even more complex to define. Learning itself may be expressed as a way of interacting with the world (Biggs, 1999), the adaptation of the learner's ability to respond appropriately to a given task (Obitko et al, 2001), and/or as an active process of constructing knowledge (Duffy and Cunningham, 1996) rather than just acquiring it. In the early teaching theory, educational processes were viewed as the communication of knowledge to the student (Siemer and Angelides, 1998), and according to Wenger (1987), such form of knowledge communication could be defined as the ability to cause and/or support the acquisition of one's knowledge by someone else, via a restricted set of communications. Further, the degree and type of learning interaction vary according to learning theory. For example, behaviourism supports routines of activities, and immediate feedback (Kuhn et al, 1996 cited El-Saddik, 2001), cognitivism supports exploration, experimentation, and problem solving (Anderson, 1996), and constructivism supports involvement and construction of knowledge through real situations (Koshmann, 1996). However, learning theories should not be treated as solid rules, but as guidelines (Snelbecker 1999) or as trials that need to be tested (Popper 1957).

As learning is a holistic process, which does not only involve interaction with information or knowledge in a direct manner, but also it utilises interaction with others (Boud et al, 1993), it is therefore achieved by total engagement (Alexander and Boud, 2001). Interactivity of learning can take different shapes through using different types of learning interaction, which can be categorised into three main types: student-content where learner interacts with information (S-I), student-teacher (S-T) where the learner interact with experts, and student-student (S-S) where the learner interacts with other learners (Moore, 1989; Hillman et al, 1994; Moore and Kearsley, 1996). Further, most learning happens independently and people consider they learn best at their own pace, at times and places of their own choosing, often with other people around (especially fellow learners), and when they feel in control of their learning (Race, 1994). Harasim (1989) emphasised the positive effects of active engagement.
in learning, sharing information and perspectives through interaction with other learners. As can be seen above, the terms interactivity and learning seem to incorporate overlapping elements such as interactions with information, peers and teachers. They also incorporate factors such as active engagement rather than passive one and that the degree and type of learning interaction may vary according to learning theory. However, the definitions do not particularly give enough consideration to learners' differences or distinct between them. As learners differ in many ways, without appropriate investigation of such differences it is difficult to define, plan or develop effective interactive learning designs. The following subsection will be discussing learning preferences in more detail. It will look particularly at some definitions; problems associated with their definitions, assessment and consistency.

2.2.2 Learning preferences

Learners differ in many ways, thinking, culture, age, personality, gender, learning styles, perception, abilities and intelligence (Riding and Rayner, 1998). They vary on a wide variety of psychological dimensions and such differences (Individual Differences) can have effects on many types of mental operations (Parkin, 2000). The theme of learning preferences is a large body of research that can help in the understanding and decision making in relation to strategies that work best for different types of learners. Investigating such differences is essential because, humans are different and perceive the world in different ways; understand and learn in different ways and under different conditions (Birkey and Rodman, 1995; Claxton and Murrell, 1987; Felder, 1988; Pask, 1988). The notion of perception, as one of such differences, has been investigated by many authors (Marton and Booth, 1997; Biggs, 1999; Prosser and Trigwell, 1999). According to Harre (2002), perception of something as something is not just a response to a stimulus, it is the upshot of a cognitive process. It is the conscious experience or awareness of surroundings and sensations (Goldstein, 2005). It equips the person with a useful view of the world, one that helps to interact effectively and safely with the environment, and stresses the important and diminishes the irrelevant (Sekuler and Blake, 2002). Students' perceptions of learning tasks may affect both how they are approached and degree of success achieved (Hounsell, 1997).

Learners also use different learning strategies (Riding and Rayner, 1998), perceive and process information in different ways (Felder, 1993) and consequently develop different patterns of behaviour that they are most comfortable with, which are more commonly referred to as their learning styles (LSs). According to Keefe (1979), LSs are considered to be “characteristic cognitive, affective, and psychological behaviours that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning
environment” (1979, p.4). The complexity of human beings makes it difficult to find one style that perfectly represents every individual (Lockitt, 1997). Classifying learners as Active or Reflective, Visual or Verbal, or else is the subject of much debate and research (Keefe, 1979; Curry, 1983; Kolb, 1976; Kolb, 1984; Witkin et al, 1977; Honey and Mumford, 1992; Sadler-Smith, 1996; Canfield, 1992; Ladd and Ruby, 1999; Felder and Silverman, 1988; Felder and Solomon, 1999; Gardner, 1993; Moore, 1999). Some learning styles categories include preferences for learning visually, auditorily, or kinesthetically (touching, feeling, or hands-on) or preferences for working in groups or individually. Others may include bodies of research on different learning theories, learning contexts, brain functions, and the dynamic nature of learning, learning habits, different learning situations, and reactions to changes in environment. Any learning preference assessment (or LS), is a snapshot of student’s view or perceived preferences. As every human being is a unique, complex and sophisticated individual that represents a product of a comprised collection of attributes such as experiences, cultures, environments, attitudes and many more variables. Thus any assessment or evaluation will not be comprehensive or complete, but is merely an initial step for better understanding of the student’s learning preferences and needs.

Some problems are linked to learning styles theories (Curry, 1990), such as, confusion surrounding their definitions, weaknesses in the reliability and validity of instruments used, and the identification of learners’ relevant characteristics and instructional settings. Birkey and Rodman (1995) notes that, just as there are clear differences in the way people learn and process information, there are also clear differences in the way LSs are defined and measured. Furthermore, much of the LSs research is mainly concerned with its categorisation (De Vita, 2001), and little attention is given to how this information can inform the interactivity design. Tennant (1997) and Laurillard (1993) question the applicability of these styles, saying that the individual learner is likely to adapt the LS to fit a given context (context-dependent) rather than being different discrete types of learners (context-independent). Further, Kember et al (1997) argues that learning approaches can be influenced by various contextual variables that constitute the learning and teaching environments. On the other hand, Riding and Rayner (1998), considers such adaptation as learning strategies rather than LSs in that, LSs has physiological basis and fairly fixed for the individual, whilst learning strategies are ways that are developed to adapt and deal with different learning tasks to make use of one’s cognitive style effectively (Riding and Rayner, 1998). Entwistle (1981), also notes that, both consistency and variability in students approaches to learning are possible, and that the learner’s tendency to adopt a certain approach, or preference of a certain style of learning, may be useful way of describing differences between students, however a more complete
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explanation would also involve looking at the way an individual student's strategy may vary from task to task (Entwistle, 1981). This view was also supported by Ramsden, (1992), who indicated that, although the same student can use different approaches on different occasions, the tendency to adopt particular approaches proves true, thus variability in approaches coexists with consistency. Further, some have investigated the influences of several factors in the development and shaping of LSs preferences such as direct and indirect influences of culture (De Vita 2001; Kolb and Fry 1975; Triandis 1989; Pratt 1991; Pratt 1992; Jackson 1995; Hayes and Allinson 1994), individualism-collectivism (Auyeng and Sands 1996), family and school (Kolb and Fry, 1975) and the level of prior knowledge (Kirby and Boulter, 1999).

As can be seen, learners differ in many ways, and that can lead to questions that need answers. Some of which are related to the consistency of LSs at different levels of study, and how influential is student’s perception on his/her attitude towards learning interactions, as important elements of interactive learning? Whilst this study realises the importance to explore and investigate all students’ individual differences and learning preferences to enhance the interactivity of course design, it has to limit its scope. Possible areas of learning preferences that can be investigated in this study are LSs and students’ perception due to their possible influence on students’ attitude towards learning interactions, the focus of this research. Having said that, this study does not underestimate the influences of other factors (for examples, culture, gender, age, motivation, mood, idiosyncrasies, fashion, emergence etcetera), and recommends their exploration and investigation as future research. The following sub-section will be discussing LSs, the main focus of this study, in more detail. They will look particularly at some LSs dimensions, and identify the ones that will be investigated in this research and reasons behind their choice.

2.2.3 Learning styles dimensions

LS models that categorize different learning modes may provide good frameworks for designing interactivity for learning through accommodating students learning preferences, some of which are Kolb’s (Kolb, 1976), Honey and Mumford’s (Honey and Mumford, 1986), The Myers-Briggs Type Indicator (Lawrence, 1994; McCaulley, 1990; Myers and McCaulley, 1985), Entwhistle’s (Entwhistle, 1979), and Felder’s model (Felder and Silverman, 1988; Felder and Soloman, 1999). There are several LSs dimensions that are related to interactivity and interactions such as the Active-Reflective, Visual-Verbal, Global-Sequential and Intuitive-Sensory (Felder and Silverman, 1988); Field Independent-Field Dependent (Witkin et al, 1977); Abstract conceptualization-Concrete experience and Experimentation-reflection...
dimensions (Kolb and Fry, 1975) and many more that feature distinct as well as overlapping attributes. However, this study has to limit its scope. Whilst there are several LSs models that may have some relevance to ILSs, none of them are perfect (Curry, 1990), however they give an opportunity to learn about the student’s preferred LS. Some of the LSs that are viewed in this study as closely related to interactivity and learning interactions (the focus of this study), are the Active-Reflective and Visual-Verbal dimensions of LSs respectively. This is because the former dimension is related to information processing and the extent to which active and interactive engagement, in physical activities or discussions with others, should be applied in the design. The latter dimension is concerned with the presentation of learning interactions, whether through the use of pictures (static or dynamic) and/or words (spoken or written), and the extent to which different presentations should be applied in the design. One possible LSs models that can be used to represent these two dimensions is Felder and Silverman’s (1988) model as it is synthesized from a number of studies and models, with dimensions such as Active-Reflective and Visual-Verbal dimensions. Its ease of use (Montgomery, 1995), clarity of its instrument (Zywno, 2002, 2003), and the variety of information available that covers several aspects of it had added value. It has been used in several studies (Rosati, 1999; Montgomery, 1995; Kuri and Truzzi, 2002; De Vita 2001; Sabry and Baldwin, 2003), evaluated and argued to be appropriate and statistically acceptable for characterising learning preferences (Zywno, 2003).

Felder and Silverman (1988) describes Active learners as they tend to retain and understand information best by doing something active with it (Table 2.1), for example through discussion, trial and/or application, sitting through lectures passively, only taking notes is seen to be hard for active learners. Active learners tend to like group work and discussion of ideas. Some researchers argue that student’s learning is socially mediated and that knowledge is an active mental construction that derives from prior social interaction (Palinscar, 1998; Wertsch, 1991). Further, Harasim (1989) emphasised the positive effects of active engagement in learning, sharing information and perspectives through interaction with other learners. According to Laurel (1990), learners learn best when they are engaged actively and continuously in the learning process (which are some of the attributes of interactivity). Section 2.3 will explore the Active LS in relation to CMLIs, and whether or not it has or has not been addressed in terms of CMLIs in general and more especially at different levels of learners’ course of study.
Table 2.1 LSs dimensions based on Felder (1993)

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Categorisation</th>
<th>Preferences</th>
</tr>
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<tbody>
<tr>
<td>VISUAL-VERBAL (VIS-VRB)</td>
<td>Perception of sensory information: pictures, diagrams, graphs, demonstration.</td>
<td>Tend to remember best what they see static pictures (eg diagrams) or dynamic pictures (eg videos, DVDs).</td>
</tr>
<tr>
<td>VISUAL-VERBAL (VIS-VRB)</td>
<td>Perception of sensory information: sounds, written, spoken words, formulas.</td>
<td>Tend to get more out of words (written and spoken explanations).</td>
</tr>
<tr>
<td>ACTIVE-REFLECTIVE (ACT-REF)</td>
<td>Information processing: through active and interactive engagement in physical activity or discussion.</td>
<td>Like trying things, discussing what they learn, applying it or explaining it to others. Tend to like groupwork. Find it hard sitting in lectures only taking notes without doing something active.</td>
</tr>
<tr>
<td>ACTIVE-REFLECTIVE (ACT-REF)</td>
<td>Information processing: through introspection.</td>
<td>Prefer to think about what they learn quietly first. Prefer working alone. Find it hard sitting in lectures only taking notes without given the chance to reflect on what has been learned.</td>
</tr>
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</table>

Reflective learners tend to do much more of their information processing introspectively (do the processing in their heads), retain and understand information best by thinking things through first. Sitting through lectures passively without having to reflect on what has been taught seems hard for Reflective learners. Reflective learners tend to like to work alone, prefer theories, interpretations of factual information, prefer the spoken or written word, and must get “big picture” before individual pieces fall into place. However, students do not automatically stop to reflect on their thinking, and often teachers do not carry sophisticated tools or resources to achieve that (Lin et al, 1999). The ability to think reflectively is important in order to make sense of information learned and adapt it flexibly to new situations (Bruer, 1993). Thus, people who are able to adapt what they have learned to new situations are those who often reflect on their understanding and seek to go beyond what they already know (Bransford and Nitsch, 1978). Therefore, educational systems should be designed not only to enable students to search for information, or teach specific contents but also to provide the platform that enhances reflective learning environments (Lin et al, 1999). Section 2.3 will explore the Reflective LS in relation to CMLIs, and whether or not it has or has not been addressed in terms of CMLIs in general and more especially at different levels of learners’ course of study.

On the other hand, Felder and Silverman (1988) and Felder (1993) describe Visual learners as they remember best and get more information from what they see (for example, pictures, diagrams, flow charts, films, and demonstrations) than from verbal material (written and spoken words and mathematical formulas). If something is simply said and not shown to Visual learners (for example, in a lecture) there is a good chance they will not retain it. Verbal learners get more out of words (for example, written and spoken explanations) than from
visual images (pictures, and diagrams). Most people, particularly in science are Visual learners (Barbe and Milone, 1981), however in most lectures; very little information is presented visually. Students mainly listen to spoken words (for example, lectures) and read written words (for example, material written in textbooks, on black or white boards and handouts), rather than watching pictures (whether static or dynamic), which results in that most students do not get enough benefit as they would if more visual presentation were used more often (Felder, 1993), particularly this will be essential consideration for Visual students. Faraday and Sutcliffe (1997) find also that the use of picture (static and dynamic) have positive effect on user performance particularly in information recall. Using different mixture of pictures (static and dynamic) and text (written and spoken) will help accommodate different learning styles (such as Visual and Verbal) and will contribute to their learning. According to literature review (Williams, 1998); combining visual and spoken words can enhance comprehension in comparison with using either of them solely. This was supported also by other research (Lee and Bowers, 1997). Further, Tindall-Ford et al (1997) find for example, visual-audio combinations are more effective for complex tasks rather than easy ones, and integrated written words and diagrams are better than just written words due to the reduced demands on working memory. This is not to ignore the cognitive load aspect (Chandler and Sweller, 1991; Sweller and Chandler, 1994) where the integration of different information presentation modes (S-I) and different learning methods can play an important role in the learner's learning. Section 2.3 will explore the extent to which Visual and Verbal LSs have or have not been addressed in terms of CMLIs in general and more especially at different levels of study.

Further, according to Mayer (2001), low knowledge learners are less able to engage in useful cognitive processing when the presentation lacks guidance, that is, they are not able to generate their own mental images while listening, for example, to an audio recording or reading a verbal text so having a contiguous visual presentation is needed. Illustrations help learners with low prior knowledge to recall textual explanatory information and to solve creative problems but that adding illustrations to the text does not generally affect the learning performance of learners who have high prior knowledge of these devices. Other studies, in different contexts, support this view, namely, in the teaching of natural science subject (Kraft, 1961), geology and meteorology to college learners (Dean and Enemoh, 1983; Kunz et al, 1989) and basic training information to army recruits (Kanner and Rosenstein, 1960; Kanner et al, 1954). However, it should be noted that it was not always consistent (Mayer and Gallini, 1990). Section 2.3 will explore whether or not learners at different stages of their course or
with low/high knowledge have or have not been addressed in terms of effect on students LSs and/or use of CMLIs.

Although learners may not strongly exhibit particular LS, this should not be underestimated as it can help in developing certain skills and cognitive qualities in addition to allowing learners to learn in different ways (Entwistle, 1988). Felder (1993) therefore suggests that we should consider the use of variety of LSs in order to develop and strengthen learners' LSs. Thus taking that in mind, in terms of designing an ILS, we should cater for learners existing LSs and cater for the skills that are required to be developed or strengthened. According to Biggs (1999) two teaching approaches can be identified, the deficit and contextual approaches. The deficit approach is based on assimilation or accommodation of students' differences, while the contextual approach is inclusive and combines elements of both assimilation and accommodation. Felder (1996) further argues that if teachers teach exclusively using their learners' less-preferred LS, the learner's level of frustration and discomfort may become high enough to interfere with their learning, while if they teach exclusively using their learners' more preferred styles, the learner may not develop the skills required to reach their potential. This further raises some questions, as to what extent the styles exhibited should be accommodated, and to what extent the non-exhibited or weak styles should be considered for developing necessary skills. Furthermore, what are the interactivity considerations that should be incorporated taking into account the variations of LSs? Other area that needs more explorations before reviewing literature on CMLIs (next section) is to look at some learning models that have addressed interactive learning in terms of students' differences and to what extent they have been considered? This will be the topic of the next subsection.

2.2.4 Learning models
Learning models help to highlight constructs or areas of concern and influential factors that may have some affect on learning. One of the models that consider learners' differences is Biggs' (1989) 3-P Model of Learning. Biggs (1989) argues that the teaching process associated with deep learning approach, should include high degree of learner activity and interaction with both peers and teachers. The model (Figure 2.1) includes elements of both individual differences and instructional design. It represents an integrated design that incorporates three influential and interacting components, presage (personal and situational factors) that exist before starting a particular course of learning, Process (approach the student adopt to learning tasks, whether deep or surface) and Product (learning outcomes). Despite that the model considers learners differences, it neither addresses specific types of
LSs nor design aspects related to different types of learning interactions. Further, the model looks at the *end product* (performance or learning outcome), which is not investigated by this research as it focuses on students’ attitude and preferences that concern their learning interactions. By doing so, it aims to improve the interactivity design and consequently may layout a suitable ground for improving learning outcome. Some research has shown positive results on student’s learning outcome when the learner is able to use their preferred learning method (Campbell and Campbell, 1999). After all, performance is a result of many factors some of which are tangible and some are not easy to measure. Whilst learning interactions do not necessarily have direct effect on student’s performance, it seems to have positive effect on student attitude towards their learning (Kearsley, 1995; Fulford and Zhang, 1993). This study adopts Rieber’s (2001) view that the design should not only be concerned with students’ learning performance, but also with their attitude and feelings towards learning interactions. However, this study realises that designers, understandably, are essentially concerned that learning occurs as well as improving the student’s learning experience, and that the actual proof of students’ short term success is in achieving what is commonly known as students’ *performance* or their *tangible* behaviour.

![Figure 2.1 The 3-P model (based on Biggs, 1989)](image)

However, it also recognises that learning itself is difficult to measure, except by making a logical judgment based of circumstance involved and prior conclusions rather than direct observation or results. That is for example being able to identify observable change in attitude, or in other words, precise or measurable outcome of learning, that is, recall,
comprehension, application, analysis, synthesis or evaluation (Bloom, 1956). In order to find out why learners do what they do, it is necessary to look at students' learning preferences as this is necessary for those teaching or designing ILSs to be able to assist students in developing the required learning skills. Therefore, it is essential, not only to look at performance and learning outcome, but also to look at factors such as students' learning preferences, LSs, perception, the relation between them, and their affect on what they actually do to learn. Further, if student performance can be viewed not only on the basis of fixed attributes (for example intrinsic talents, or abilities) but also on changeable attributes (for example, change in behaviour), then the focus on the adaptation of the interaction design in relation to factors such as LSs, learning preferences and perception will be essential.

Another model that deals with adaptivity and interactivity aspects is Laurillard's (1993) Conversational Model which incorporates interactivity elements that are represented in several characteristics that engage the student in the learning process, such as being Discursive, Adaptive, Interactive and Reflective. However it deals mainly with student-teacher (S-T) interaction and does not clearly or specifically highlight or incorporate other interactions such Student-Student and Student-Information interactions. Despite that the model considers interactivity and adaptivity; it neither addresses specific types of LSs nor design aspects related to different types of interactions.

To recap, this section explored some of the general concepts related to interactivity and learning including Interactive Learning and Learning preferences that might help identifying and highlighting areas of concern and/or influential factors that might have implications on the interactivity design of learning systems with emphasis on HE. It reviewed literature on interactivity definitions and characteristics, learners’ learning preferences and learning styles with its variability and consistency aspects, and learning models. As can be seen above, the terms interactivity and learning seem to incorporate overlapping elements such as interactions with information, peers and teachers. They also incorporate factors such as active engagement rather than passive one and that the degree and type of learning interaction may vary according to learning theory. However, the definitions do not particularly give enough consideration to learners’ differences. Further, some questions arised from the above review. For example, how consistent are LSs? And how influential would students’ perception on students’ attitude towards, for example learning interactions, as an important element of interactive learning? Whilst this study realises the importance to explore and investigate all students’ individual differences and learning preferences to enhance the interactivity of course design, it has to limit its scope. Possible areas of learning preferences that can be investigated
in this study are LSs and students' perception due to their possible influence on students' attitude towards CML interactions, the focus of this research. Having said that, this study does not underestimate the influences of other factors, and recommend their exploration and investigation as future research. Some of the LSs that are viewed in this study as closely related to interactivity and learning interactions (the focus of this study), are the Active-Reflective and Visual-Verbal dimensions of LSs respectively. This is because the former dimension is related to information processing and the extent to which active and interactive engagement, in physical activities or discussions with others, should be applied in the design. The latter dimension is concerned with the presentation of learning interactions, whether through the use of pictures (static or dynamic) and/or words (spoken or written), and the extent to which different presentations should be applied in the design. One possible LSs models that can be used to represent these two dimensions is Felder and Silverman’s (1988) model as it is synthesized from a number of studies and models, with dimensions such as Active-Reflective and Visual-Verbal dimensions. As indicated in literature, its ease of use, clarity of its instrument, the variety of information available that covers several aspects of its application, has been used in several studies, evaluated and argued to be appropriate and statistically acceptable for characterising learning preferences.

The above literature also raised some questions, as to what extent the styles exhibited should be accommodated, and to what extent the non-exhibited or weak styles should be considered for developing necessary skills? Furthermore, what are the interactivity considerations that should be incorporated taking into account the variations of LSs? Despite that the models described above considered the notion of learners' differences, they neither addressed specific types of LSs nor design aspects related to different types of learning interactions. Sections 2.3 will begin with reviewing literature on work done on computer systems that relates to interactivity, as the discussion of a reference theory outside the context of learning can strengthen the understanding of what actually is done and the implications of the choices that are/ are not made. Then the same section and the following one (section 2.4) will look at CML that relates to interactivity and LSs in general and the Active-Reflective and Visual-Verbal dimensions in particular. This will help exploring interactivity characteristics and practices; models related to the user and use of technology; different aspects related to ILSs, namely, the learner, technology, pedagogy, subject information and different CMLIs; and identify gaps for further investigation and exploration in terms of interactivity adaptation and design models and considerations.
2.3 Interactivity and computer-mediated learning (CML)

2.3.1 Interactivity of IS: definitions and characteristics

This subsection discusses some reference theory outside the context of learning in order to strengthen the understanding of what actually is done and the implications of the choices that are/ are not made. Similar to interactive learning (section 2.2), the term interactivity is widely used in computing, but there appears to be no consensus of what it really involves. Adding to the complexity of the term is the use of technology for different types of interactions. Daft and Lengel (1984, 1986) identified four key factors associated with the use of technology for interaction in their proposed concept of media richness (the ability of media to improve human understanding) which incorporates elements of interactivity. Immediacy (timely feedback), multiple cues (the ability to transfer messages through differing cues), language variety (the use of different words to increase understanding) and personal source (the ability to transmit feelings and emotions). Sproull (1991) and Valacich et al (1993) added other factors such as multiple address-ability (communicating information simultaneously to more than one user, externally record-able (documenting and modifying the communication process), computer process-able memory (the organization and manageability of communication), and concurrency (interactivity with more than one user at once). Further, Galitz, (2002) compiled several factors that contributes an interactive design, some of which are flexibility, controllability, response and feedback. Flexibility, in particular, is increasingly becoming an important and essential design criterion; however its implementation is not without problems (Earle, 2002). Sørensen and Pica (2003) have taken the notion of flexibility through technology mediated interaction further through their research on mobile technologies and the mobilization of interactions whether between users and/or between users and information towards what they described as fluid interaction, where temporal, spatial and contextual aspects of interactions become more flexible compared to non-mediated or traditional interactions. Evans and Sabry (2002, 2003) proposed and described three interrelated actions, initiation, response, and feedback that make a design interactive. They considered the lack of any of these actions would have a negative effect on the interactivity design. The authors further compiled a set of interactivity heuristics that contribute to interactivity which include frequent user's engagement, varying interactions, allowing for reflection, using multimedia, and providing choice.

Laurel (1986, 1993) characterises interactivity level based on three criteria or variables: frequency of interaction, range of choices available, and significance of these choices in terms of their effectiveness while Preece et al (2002) argues that interactive computer designs have certain characteristics some of which are that they should be satisfying, enjoyable, motivating,
aesthetically pleasing, support creativity, rewarding, and emotionally fulfilling. Interaction can be represented as a cycle where the user has an intention, performs an action, observes and evaluates the effect of the actions and then acts accordingly on its results (Norman, 1988). Similarly, Barker (1994) describes the basic principle of interactivity based on interaction in dynamic system theory (interaction between two dynamic processes: such as the learner and computer) where successive messages are sent between them which cause change of state on receipt of the message, and generate a new message. As can be seen above, interactivity of Information Systems may incorporate elements such as the ability to provide feedback, interactions with information and users, flexibility and effective use of multimedia. Despite that all these elements can inform interactive learning designs (which will be reviewed and discussed in more detail in the following subsection), there is no specific focus on users' individual differences, different needs, or preferences towards different computer-mediated interactions.

2.3.2 Interactivity and learning systems: benefits and characteristics

Interactivity is at the heart of learning systems design for the influential role it plays in the effectiveness of the learning process (Moore and Kearsley, 1996), and is considered as one of the potential advantages of web-based learning systems (Evans and Sabry, 2002). Using an interactive web-based learning program can increase the learning enjoyment level, which in turn may increase the student's understanding and the effectiveness of learning in a longer timeframe in terms of information retention (Street and Goodman, 1998). Laurillard et al (1994) argues that interactive technology not only can support some of the cognitive processes of learning, but also it can support the affective elements of motivation and enjoyment that enable the cognitive processes to be engaged. Some authors have argued that interactivity of CML can boost the speed and level of student learning (Horton, 2000; Najjar, 1998), as an essential element for productive learning (Cohen, 1994), and helps to improve student confidence and motivation (Klassen et al, 2001). Based on a series of research (Adams, 1992), it has been found that students who use interactive multimedia had a 55% learning gain over students receiving traditional classroom learning, and that students learnt material 60% faster, and their long-term (30 days) retention was from 25% to 50% higher. Many studies have concluded that the increase in levels of interaction can have positive effects on students' motivation, satisfaction, attitude toward learning, effective and more meaningful learning, and learning outcome (Ramsden, 1988; Garrison, 1990; Entwistle and Entwistle, 1991; Hackman and Walker, 1990; Ritchie and Newbury, 1989; Schell and Branch, 1993; Wagner, 1994).
There have been several attempts to define the interactivity of computer and web-based systems (Laurillard, 2002; Graham et al, 2000; Reeves, 1999; Laurel, 1986; Laurel, 1993) that support a learner-centred design. Interactivity of learning systems can be claimed to have certain features or mechanisms that allow students to act to achieve certain tasks, receive relevant intrinsic feedback on their actions, and a sort of change occurs as a result of their reactions (Laurillard, 1993), or can feature a reciprocal interchange between the learner and the instructional medium (Reynolds and Iwinski, 1996). According to Reeves (1999), learning environment can be described as interactive when it allow a person to perform meaningful activities such as navigating through it, selecting information, responding to questions using computer input devices such as a keyboard, mouse, touch screen, or voice command system, solving problems, completing challenging tasks, creating knowledge representations, collaborating with others, or otherwise engaging in meaningful learning activities. Interactivity of learning systems can take different shapes through using different types of learning interaction, which can be categorised into three main types: learner-content where learner interacts with information, learner-instructor where the learner interact with experts, and learner-learner where the learner interacts with other learners (Moore, 1989; Hillman et al, 1994; Moore and Kearsley, 1996). Therefore, the concept of interactivity suggests a form of participation process that involves a sort of reinforcement of a reciprocal relationship between subjects with a technological object (Whaley, 1995). Technology, particularly the Web, has the potential to play a significant role in supporting student reflection; however it requires new kind of knowledge and learning skills (Lin et al, 1999). Evans et al (2002) stress the importance of allowing for reflection as an important element of interactivity. They combined a set of principles (heuristics) for interactive systems, which includes not only appropriate use of multimedia and active engagement of the learner, but also allowing for reflection which can help learners in filling the gaps in their own understanding (Lin et al, 1999).

ILSs should therefore, adopt some principles in the design such as active learner's engagement (Laurel, 1990; Alexander and Boud, 2001), active thinking (Salmon, 2002), engagement of the learner with a variety of interactions with materials, peers, and experts (Bonk, 1999; Park, 2003), flexibility in expanding interactions beyond the lecture or tutorial in case of campus based learning (Jung et al, 1998), allow for reflection and provide feedback (Laurillard, 2002), provide choices, easy navigation, variety of interaction patterns, and use of multimedia (Evans et al, 2002) including graphics which may promote discovery and inference (Mayer, 1989; Tessler et al, 1995). Despite that interactivity of learning systems having been described in different ways, in most cases such definitions and designs do not
take into account actual learners' differences including for example, LSs, their use and perceptions of usefulness of different types of types of CMLIs, or learning preferences in relation to traditional methods. The following subsection will look at the issue of learners' differences in more details.

2.3.3 Considering learners' differences in ILSs' design

Learners differ in many ways (as described in section 2.2) including LSs, learning preferences and their perception of the world. Such differences may have influence on learners' use of learning systems. For example, learners' perceptions of learning contexts where learning technology is incorporated may have some influence on the success of integrating learning technology, particularly in terms of the degree of its use, the ways in which it is used, and teachers' and students' expectations about learning (Parr, 1999). Some authors looked at users' perception and attitude towards the technology used and found positive association between IS use and perceived usefulness (Davis, 1993; Al-Gahtani and King, 1999). Melone (1990) and Srinivasan (1985) looked at IS use as a key indicator, however concluded that it can be affected by a number of complicating factors one of which is the nature of system use whether mandatory or discretionary. A study of students' perceptions of learning contexts that incorporated learning technologies by Parr (1999), found that students' perceptions influence the success of technology integration, in particular the way it is used, type of technology, and teachers' and students' expectations about learning.

Conceptual and design models that address the use of technology and/or users' differences can help in highlighting constructs or areas of concern in relation to influential factors that may affect ILSs' design. One of these models that addressed users' preferences and different perceptions and attitudes towards technology, and can be viewed as relevant for learning systems' design, is the TAM (Technology Acceptance Model) by Davis (1989) and Davis et al (1989), which constituted factors that may help in predicting computer use, including perceived usefulness and perceived ease of use (Figure 2.2). Where the perceive usefulness of IS can be defined according to Davis (1989) as "the degree to which a person believes that using a particular system would enhance his/her job performance" and the perceived ease of use as "the degree to which a person believes that using a particular system would be free of physical and mental efforts" (p320). However the model does not specifically look at learning aspects or students' differences in terms of LSs, different types of CMLIs, and/or learning preferences in relation to traditional methods, which can be explored further in this study in terms of the perceived usefulness of the 3-CMLIs.
Further, O'Malley and McGraw's (1999) Student Perception Model (which is adapted from Roger's Diffusion of Innovations model (1995) also highlights influential factors on student's perceived effectiveness of CML, taking into account important factors such as characteristic of the student and perceived characteristic of CML or Online learning, and prior educational conditions on the perceived effectiveness of CML (Figure 2.3). However, the model does not specifically focus on LSs and attitude towards different CMLIs.

Similarly, Collis's 4-E model (Collis et al, 2000), argues that an individual's likelihood of using WBL for learning assuming a voluntary choice is involved can be expressed in terms of four groups of factors. One, perceived Educational Effectiveness. Two, Ease of use. Three, personal Engagement and Environment (where the 4th E depends on influences related to
one's educational organisation, social environment and perception of technology push in daily
life). Actual use of computer systems may also be influenced by factors such as matching user
needs in achieving a particular task (Goodhue, 1995) and whether the use of the systems is
based on voluntary or non-voluntary use (Welke and Konsynski, 1980). Keller’s (ARCS)
model on the other hand, argues that a person's motivation to a topic can be increased if it can
gain person's attention, it is relevant to the person, the person is confident to master it, and it
gives the person satisfaction (Keller, 1983). Despite, that motivation is not the focus of this
research; the model highlights the importance of accommodating the user and its positive
influence on the student's learning. Other, authors address learning systems from a user-
modelling perspective, where the system has a model of the user with whom it is interacting,
including necessary information such as user's attitudes, preferences, knowledge and beliefs
(Allen, 1990). The user-modelling perspective can be useful in term of the adaptation of the
learning system to student's differences; however it may also restrict the students and limit
them in developing new skills.

Integrating interactivity in the design of learning systems is still evolving (Driscoll, 1998),
and its implementation can be complex and cumbersome, requiring skills from across
disciplines including, among others, software engineering, human computer interaction
(HCI), learning theories and cognitive psychology (Evans et al, 2002). Furthermore, it
requires understanding of the complex interactions between teachers, students and technology
(Honey et al, 2000). Despite the advocated advantages of interactivity as an important aspect
of any effective educational technology, some research did not find significant impact from
using interactive learning in terms of a direct increase of knowledge level in comparison with
non-interactive, however it was suggested that it brings enjoyment to learning, and
consequently provides focus to understand the information taught (Street and Goodman,
1998). But because interactivity is not an inherent property of a learning system, and it only
happens when it is considered in the design in order to achieve certain learning goals through
interactions (Street and Goodman, 1998), it is important to know more about the user
(learner), how they perceive different CMLIs, as well as understanding of such technologies
capabilities (Sims, 1997). However, in most cases the interactivity qualities or principles are
not fully utilized or adopted (Nelson 1990; Sims, 1999; Sims, 1997; Dickinson, 1995;
Cairncross and Mannion, 2001; Evans et al, 2002; Maddux 1996), and generally based on
logical principles rather than empirical knowledge about the student’s learning (Laurillard,
2002) or qualitative studies about students’ different LSs.
Chapter 2: Interactive Learning Systems and Learning Styles

Despite that the above mentioned models and studies touched on the importance of considering the user (learner), for example, in terms of the user's *perception*, there is no explicit or specific mention of students' different LSs and how they may contribute to their attitude to different types of CMLIs and how to accommodate them. Further, whilst both *active* engagement, *reflection*, use of multimedia, and taking account of the user (learner) are considered important characteristic of interactive systems, there is a lack in literature in investigating related LSs such as Active-Reflective and Visual-Verbal. Further, there are currently no generally agreed models, frameworks or design principles for a complete ILS structure that also incorporates different LSs and different CMLIs. This is also stressed by Tearle (2003), that the process of identifying, structuring the necessary pedagogic and design framework is quite complex, particularly when taking into consideration different LSs (Jones et al, 1997). Based on the literature reviewed in the previous sections in relation to interactivity, interactions, learning theory, LSs, and technology, the following section will look particularly at the structure of a learning system in terms of possible components and the position of CMLIs within that structure. In other words it will look at the big picture as well as the specific focus of this research.

2.4 Structure of a learning system

2.4.1 Components of a learning system

Based on the reviewed literature above this study suggests four main interrelated elements or components that comprise a learning system (Figure 2.4): the *learner, technology, subject,* and *pedagogy*. The *Learner* component is concerned with knowledge about the learner such as individual differences (for example, gender, prior knowledge, age, culture and special needs), preferred LSs (for example, Active/Reflective and Visual/Verbal), attitudes and beliefs. The *Subject Information* component, include information that constitutes relevant subject knowledge required to be learned including internal information or actual contents provided (subject material) and other external information that are relevant or supplement subject material (For example, searching the internet for information such as papers relevant to subject material), items to be taught, course aims and objectives, and skills to be developed.

![Figure 2.4 Components of learning systems](image-url)
The *Technology* component is concerned with *how* a course of study may be delivered in terms of different tools to be used, including usability, interactivity, navigation, and HCI aspects of learning systems. It also includes hardware issues, for example whether static (PCs) or mobile (PDAs). The technology component is an important part of the learning system, but should not be treated as a determiner of the system design or treated in isolation of the other components. It includes knowledge about the media through which information can be delivered, for example, e-mail, internet search engines, learning environments such as FirstClass, WebCT and Blackboard, where the three types of learning interaction can be accommodated, including different combinations of multimedia representations to accommodate different types of interactions, teaching and learning styles. Learning environments generally include four main components, an enabling context, resources, tools, and scaffolds (Hannafin et al, 1999). Multimedia learning technologies can provide different combinations of picture (static and/or dynamic) and word (written or spoken) (Mayer 2001; Najjar, 1998). Hyperlinks can allow learners to find their way through the learning system with appropriate navigation design (Evans and Edwards, 1999). Whilst this study views technology as a tool and a *black box*, it does not underestimate the importance of the understanding of ICT (Information Communication Technology) artifact, as part of the *Technology* component of an ILS, in order to cope with ongoing changes (Orlikowski and Iacono, 2001) and support the adaptation notion of learning systems; however this should be in conjunction with, not on the account of, the *Learner* component and/or other components of an ILS.

The *Pedagogy* component is concerned with *how* a course of study will be delivered in instructional terms. This may include for example information about different learning theories (instructivism, cognitivism, and constructivism), instructional approaches (for example learner-centered), methods and styles of teaching relevant to the subject matter (such as problem solving, deep, surface, etc) and to different LSs and strategies, learning interactions, contexts and models of learning. Mason (1998b) describes three basic models of existing on-line learning in terms of the degree of augmentation of CMLIs: the *Content+ Support Model*, where the core of the course is based on low interaction and static content supplemented by tutorial support. The *Wrap-Around Model*, where online activities and interactions are important part of the course (50%). The *Integrated Model* is based on the integration between *content and support*, which is largely based on online interactions such as collaborative activities, discussions and joint assignments, where the contents are more dynamic, fluid and relevant to individual needs and group activities.
Whilst this dissertation adopts a learner-centred model of learning with more emphasis on learning rather than teaching, it recognises that its implementation is not without conflicts or contradictions from different pedagogical models (Earle, 2002). Furthermore, the degree of system’s interactivity will depend on how the learning system’s components are coordinated and managed. According to Klassen et al. (2001), one of the greatest challenges involved in an interactive design is the integration of freedom of choice, without losing any valuable educational endeavour. A key element to good interactivity therefore is to keep the learners engaged through the inclusion of different types of CMLIs that suit their differences as well as developing required skills. However, the questions here, is to what extent such inclusion should apply in terms of students’ differences (namely, LSs)? And what does the literature say about each type of interaction and its relevance to interactivity of learning systems? This will be next topic to be explored in the next subsection in terms of the 3-CMLIs.

2.4.2 CML interactions

Interactivity of learning systems can take different shapes through using different types of learning interaction, which can be categorised into three main types: learner-content where learner interacts with information, learner-instructor where the learner interact with experts, and learner-learner where the learner interacts with other learners (Moore, 1989; Hillman et al, 1994; Moore and Kearsley, 1996). These three categories of interaction (Figure 2.5) can play an important role in making the learning process an interactive one, by helping to adapt instructions to better suit learners requirements (Jonassen, 1988), expanding interaction beyond the lecture or tutorial (Jung et al, 1998), encouraging learners to actively process information (Bower and Winzenz, 1970), providing access to learning resources (Jung and Leeme, 1999), adding flexibility to learning (Naidu, 1997; Reeves and Reeves, 1997), and allowing learners to interact synchronously and asynchronously in collaborative and distributed based environments (Harasim et al, 1995). However, learning interactions tools’ availability in learning environments is not by itself considered sufficient and incorporating such interactions into the learning design is essential for the effectiveness of both the flow of interaction and learning (Nelson, 1999).

In many cases learning systems concentrate mainly on contents to be learned and in some cases on the skills to be developed with no or little attention to learners’ differences. Moreover, designing CML courses may be different than face-to-face (F2F) ones (Peruski and Mishra, 2004) in that, with F2F, the tutor has the ability to more directly and immediately intervene in learning compared with CML environment (Evans, 2004). In CML environment,
the cues for these three types of interactions are mainly text based, which cause the student to focus more on the ideas embodied in the text compared with face-to-face (F2F) where the focus is on the person and body language. One question here is whether students with different LSs differ in using different CML interactions and at different levels of their course.

1. **Student-information (S-I):** This category of interaction (Figure 2.6) forms the basis of all educational processes (Moore, 1989), represents mutual action between the learner, the material, and the system (Fowler, 1980), and includes active construction and reconstruction of ideas and experience (Boud et al, 1993; Alexander and Boud, 2001). The word *Information* is used instead of the word *Content* described by Moore (1989) to indicate a wider and broader meaning to include the information that is specific to course material (content) and/or non-course material that are relevant to course subject. For example this can include the learner searching the web for information relevant to their learning task or interacting with a virtual lecture. The delivery of information online "does not promote *per se* the kind of learning outcomes that constitute a university education where independent thought, reflection and abstraction are valued" (Alexander and Boud, 2001, p6).
Thus, the importance of engaging the students with the contents (information) through providing activities and opportunities to find a bridge between their existing knowledge and what they have been taught online (Alexander and Boud, 2001, p6), giving opportunities for reflection (Laurillard, 2002), and taking into consideration students’ underlying commitments about Web-based information (Tsai, 2004). Without providing such opportunities and activities, learners will attempt to memorise information rather than understanding and using it (Alexander and Boud, 2001, p7). Designing such activities is one of the important tasks to be undertaken by designers and teachers (Alexander and Boud, 2001, p7). It requires that such activities to be designed in a manner that afford generating learning (Laurillard et al, 2000; Alexander and Boud, 2001). Morris et al (1979) argued that, non verbal expressions or signals (including body language and facial expressions) can be more effective than verbal information. Written on-screen instruction lacks F2F exchange and body language, therefore should be clear (Salmon, 2002), and interactive by setting up a response and an interchange of information (McAteer et al, 2002). According to Norman (1988), interaction can be represented as a cycle where the user has an intention, performs an action, observes and evaluates the effect of the actions and then acts accordingly on the results. A key element to good interactivity is the nature and level of interaction between the learner and the media (Klassen et al, 2001). The level of interactivity design is related to the type of tasks that range in their nature and content (Klassen et al, 2001). Such interaction should include actions such as feedback and student response, as well as incorporating variety of interactive tasks (Evans and Sabry, 2003) whether computer-initiated or student-initiated (Schälir and Krueger, 2000).

Some students develop their understanding better by listening to lectures and use of text (Verbal learners), while others (Visual learners) obtain information more effectively from use of visual media such as graphics (Felder and Silverman, 1988). Through CMLIs, information can be presented in different forms such as textual, animation, simulation, audio, graphical, and/or video-clips. According to some research (Carpenter, 1999), a combination of hearing and seeing lead to higher knowledge retention (50%) compared with hearing on its own (20%). According to Meyer et al (1997) and Griffith et al (1997), multimedia applications can give students opportunities for self-paced learning in an interactive environment. Lawrence-Fowler, (2001), argued that students learn best when materials and
instruction are presented in multiple formats that engages the learner in multiple and meaningful ways. However, Rieber (1996) noted that the type of representation that is best for learning may shift over time. Furthermore, the way the learning material is structured is of crucial importance in encouraging or discouraging students to interact with it. Such structure depends on the nature of the contents, students, and aims of the course (Graham et al, 2000). However, despite the potential multimedia is believed to play in enhancing learning, there is still relevantly little evidence to support that potential (Ellis, 2001).

Furthermore, multimedia of itself does not promote reflective or active learning; it is the strategies and activities that are incorporated into the medium that are the critical elements (Rice et al, 1999). Brookes (1997) argues that where students are allowed to respond, make choices, perform, organise, think deeply about course material, active learning is generally the outcome. Active learning is often regarded as learner focused rather than teacher focused as it demands active participation beyond pointing and clicking activities (Rice et al, 1999). However, if the learner is given unlimited freedom and the learning environment does not have a clear structure; such advantages of the hypermedia environment become pedagogically disadvantageous (Burke and Papadimitriou, 2002). It is clear here that the use of activities through the use of multimedia may play an important learning role, however, what is not clear is the extent to which they should be used in relation to students' differences and what considerations should be followed to cater for them in the ILS design.

2. Student-tutor (S-T): Some studies found that learners who interacted regularly with their instructor were more motivated and had better learning experiences (Garrison, 1990). According to Laurillard (1994) the teaching-learning process is essentially a discussion between teacher and learner in the form of interaction between the teacher, the learner and some aspect of the world. A study by Mahesh and McIsaac (1999) also suggested that students displayed better commitment to their work in an online course than a traditional course because they had closer interaction with the teacher. Mahesh and McIsaac added that such close interaction can compensate the lack of control students have in highly structured distance courses. They concluded that teachers individual differences including personality, emotions, philosophy and educational background may determine the structure and design of an online course, including degree of interaction, and time spent by the teacher online (Mahesh and McIsaac, 1999).
This type of interaction (Figure 2.7) can take different forms, for example, one-to-one using e-mail, one-to-many using Bulletin boards, or many-to-many using conferencing technology. Here, the tutor can diagnose (tries to identify and interpret) a student problem and then remedies (tries to overcome/accommodate and solve-using an appropriate approach) it through continued communication and feedback. This can apply to both tutor-initiated and student initiated interactions. S-T interaction can be asynchronous using for example email and discussion board, which does not require the learner or tutor to be online at the same time. It can also be synchronous (real time) using for example chat facilities (as an online tutorial) or videoconferencing. It is clear here that the use of S-T interaction may have positive effect on students; however, what is not clear is the extent to which it should be applied and what guidelines should be followed to cater for students with different LSs.

3. **Student-student (S-S):** According to Crook (2002), learning interactions between on campus students occurs naturally in terms of seeking reassurance from each other about assignments and progress, and that they mainly relate to their learning management. However, this does not happen naturally with CML (Nicol et al, 2003) and requires careful design (Webb et al, 2004) taking into account students’ perspectives (Berglund, 2004). This type of interaction, according to Bates (1995) which enables communication between learners separated by time and distance is one of the fastest growing uses of technology in education. Student-Student interaction (Figure 2.8), and its value as a promoter for collaborative and cooperative learning, has been growing (Slavin, 1992), particularly with the use of interactive technologies (Comeaux and McKenna-Byington, 2003). Such approach has been advocated by Jonassen et al (1995) and Harasim (1990). According to Moore (1989), this type of
interaction can take different forms, for example, one-to-one (between one learner and another) or in group settings, with or without the presence of the tutor. According to Dewey (1916; 1966), learning can be considered as a social and interpretive activity in which learners collaboratively construct explanations and understandings of materials and phenomena within their environment. Some researchers argue that student's learning is socially mediated and that knowledge is an active mental construction that derives from prior social interaction (Palincsar, 1998; Wertsch, 1991).

Others describe it as a shared process that results from the participation in socio-cultural activities so that knowledge is jointly constructed and distributed amongst participants in learning groups (Wenger, 1998; Mayes, 2001). Despite that there are differences in views amongst social theorists (Salomon and Perkins, 1998), they generally agree that dialogue and interaction are essential for effective learning. This is supported by some empirical research such as Cohen (1994) and Slavin (1994). On the other hand, for encouraging active involvement in the learning process, web-based learning systems need to be relevant to different types of learners (Hall, 2002). However, recent research has indicated some distinction between CML and F2F learning environments (Crook, 2002; Pincas, 2000). Furthermore, some academics expressed their concern regarding the lack of investigation of the relationship between Web technology and pedagogy, and the focus on cognitive and affective student learning outcomes (Windschitl, 1998; Mergendoller, 1996). Many tools are used to support such interaction such as e-mail, discussion boards, conferencing, and chat facilities. Student-student interaction can take several forms: asynchronously (non-real time) through using, for example, email or discussion boards, or synchronously (real time) using, for example, conferencing and chat facilities. S-S interaction may have positive effect on students, however, it is not clear here whether
students' differences (for example, LSs) have or have not effect on their attitude towards such interaction, and the implications on ILSs design.

A key question here is to what extent and at what percentage each of these three interactions should be presented? Presenting too many interactions may not necessarily be favored by some students and could inhibit the student from the advantages of interactive learning. It is vital to use such interactions in an appropriate way to the learner and the task performed (Norman, 1993). Learners' learning preferences are intrinsic to learning (Sims, 1997), thus help to guide those involved in teaching them and to those designing ILSs to support that learning. Accommodating individual differences is one of the pedagogical dimensions of CML (Reeves, 1997) and the knowledge of the different LSs and its pedagogical needs can help developing more effective learning systems (Montgomery, 1995). However, individual differences make designing systems a more complicated task as it requires accommodating a wide range of users' characteristics (Galitz, 2002). Adding to the complexity of such variations, many teachers' teaching style is influenced by the way they themselves have been taught (Salmon, 2002). Furthermore, technology by itself, does not guarantee high quality interactions (Tolmie and Boyle, 2000), however if appropriately used, it can promote interactivity (Salmon, 2002). Achieving that, is not only by demonstrating students' learning performance (Rieber, 2001), but also by demonstrating students' attitude and feelings towards different CMLIs, through taking account of the actual user (learner), and should be based on real data through the understanding of the needs of prospective learners (Newman and Lamming, 1995). To accommodate such differences, it is important to diagnose the problem and prescribe remedial solutions. Previous studies of teachers instructional behaviour, found that diagnosis and remediation form an important part of the overall teaching interaction (Alpert et al, 1995; Winkels, 1992). For example, some learners require more help than others, particularly in relation to some subjects of study, while others are more self-motivated and require less direction and classroom support. It is hoped by such diagnosis, we will not only help the learner to "acquire knowledge of someone else's way of experiencing the world" (Laurillard, 2002, p.24), but also provide a purposeful interaction in a specific and pre-determined way to increase the learner's knowledge (Ritchie and Hoffman, 1997). How effectively, or otherwise, learners learn is dependent on many factors, such as the learner's engagement in learning-related activities, learning contexts (Kember et al, 1997) and individual differences such as, difference in prior knowledge (Bloom, 1976; Tobias, 1994), spatial ability (Mayer and Gallini, 1990), gender differences (Ford and Miller, 1996), difference in system experience (Holscherl and Strubel, 2000; Reed and Oughton, 1997), occupational experience (Durling et al, 1996), difference in cognitive styles (Durfresne and
Turcotte, 1997; Shih and Gamon, 1999), subject of study and learning styles (Felder, 1993). It would have been easier for educators if there were no differences in the way learners learn, but this is not the case. For educators, it would therefore seem important to understand the variables associated with learning so that we may (better) match or adapt our instructional style to the LSs of learners (Liu and Reed, 1994). Where adaptation of learning systems, according to Magoulas et al (2003), is about the adjustments made in an educational environment in order to accommodate and adapt to individual differences, whether through the system itself adapting its output to users' differences (adaptivity) and/or supporting user's own choices (adaptability).

As can be seen above, despite that interactivity of learning systems having been described in different ways, in most cases such definitions and designs do not take into account actual learners' differences or target learners' LSs, their use and perceptions of usefulness of different types of types of CMLIs (whether mandatory or discretionary), and/or learning preferences in relation to traditional methods. Whilst both active engagement, reflection, use of multimedia, and taking account of the user (learner) are considered important characteristic of interactive systems, there is a lack in literature in investigating related LSs such as Active-Reflective and Visual-Verbal in terms of the attitude towards CML. Conceptual and design models that address the use of technology and/or users' differences can help in highlighting constructs or areas of concern in relation to influential factors that may affect ILSs' design. However, many models do not specifically look at learning aspects of students' differences in terms of LSs, different types of CMLIs, and/or learning preferences in relation to traditional methods. Further, there are currently no generally agreed models, frameworks or design principles for a complete ILS structure that also incorporates different LSs and different CMLIs.

2.5 Summary and conclusion

This chapter explored and reviewed research in the area of students' LSs and ILSs. It explored and highlighted aspects that concern ILSs such as the main components of ILS, the 3-CMLIs and explored LSs as an important subcomponent of the Learner component of ILSs due to its link to students' learning preferences. It has explored fundamental issues in relation to interactivity for learning systems in conjunction with LSs, and argued that if we are to design ILSs then a more student-centred approach to design should be implemented. It also argued that little has been done on examining the relationship between LSs and the 3-CMLIs and consequently on the development of clear design considerations and models that guide
Chapter 2: Interactive Learning Systems and Learning Styles 39

ILSs. It also argued that in most cases the design does not take into account actual studies of the target learners' LSs or empirical knowledge of their learning preferences.

This study therefore, will try to find out whether students with different/similar LSs have different/similar attitudes towards using and perceiving CMLIs. It hypothesises that some students with particular LSs are more prepared to use CMLIs than others. It will investigate how influential LSs are on students' attitude towards CMLIs, which constitutes elements that have been highlighted in the literature such as the use and perception of CML interactions, and learning preferences in terms of traditional and non traditional methods of learning? Would different students’ LSs affect students’ attitude towards using CMLIs? How would Active students who prefer active engagement in the learning process perceive different types of CMLIs in comparison with Reflective students who prefer learning through introspection? How would Visual students who prefer learning through use of visual elements perceive different types of S-I presentations in comparison with Verbal students who prefer to use of textual elements? The extent to which the styles exhibited should be considered as fixed for a particular population of learners. The absence of design considerations, models or frameworks that are closely related to learners' LSs to inform the ILS design. The extent to which the styles exhibited should be accommodated, and the extent to which the weak or non-exhibited styles should be considered in the ILS design. What should interactivity encompass in terms of its definition and characteristics in relation to actual learners’ differences (LSs) from an ILS perspective?

The next chapter will discuss the research design that will be used to investigate the above research problems. It will present details of the approach and methodology to be used in the study, in addition to the rationale behind its use. It will explain and discuss the arguments behind the planning of the research phases, including a description and details of the questionnaires/ observation plan, details about the instrument to be used to measure students’ different LSs and description of the population of learners used.
Chapter 3- Research Design and Initial Results

3.1 Introduction

Chapter 2 reviewed research in the area of students' LSs and ILSs. It explored and highlighted several issues that concern ILSs such as the main components of ILS, the 3-CMLIs and explored the theme of LSs as a subcomponent of the Learner component of an ILS due to its link to student's learning preferences. It explored fundamental issues in relation to interactivity for learning systems in conjunction with LSs, and argued that if we were to design ILSs then a more student-centred approach to design should be implemented. It also argued that little has been done on examining the relationship between LSs and students' attitude towards the 3-CMLIs and consequently on the development of clear design considerations that guide ILSs. It also argued that in most cases the actual studies of learners' different LSs or empirical knowledge of their learning preferences are not considered in the design. This chapter presents the details of the approach and methodology to be used in the study and rationale behind its use to achieve the objectives and find possible answers to questions outlined in chapter one and arose in chapter two. One, explore and examine the LSs profile of students. This seeks to answer questions such as, what is the LSs profile of students? Does it vary amongst different groups of learners? Is there a common LSs profile exhibited? Do any further issues arise from this investigation? Two, explore and examine possible common attitudes towards the 3-CMLIs for different LSs, in terms of use, perception and learning preferences. It seeks to find out whether there are any indications of common/uncommon attitudes towards the 3-CMLIs for the LSs examined, whether there are any differences in their preferences in the two different contexts, the VDLE (Virtually Dominated Learning Environment) and TDLE (Traditionally Dominated Learning Environment), the extent to which LSs can be considered as predictors of students' attitude towards CMLIs and whether any issues or questions arises from this investigation. Three, identify and discuss possible implications of the findings on the ILS design to support its adaptation and interactivity. This seeks to identify tangible issues related to the ILS design to benefit teachers and designers and demonstrate how the key findings can be generalised or presented in a shape of initial design considerations to support its adaptability and adaptivity. Four, re-visit the 'interactivity' concept in the light of the reviewed literature and research findings in...
relation to ILSs and LSs. This seeks to identify issues that may arise from the research and have implications on the system's adaptation and interactivity design.

The following sections will discuss the research design that will be implemented in this research and help achieving its objectives, finding possible answers to its questions, as well as explaining and discussing the purpose behind the planning and design of its phases, including a description of the questionnaires and the LS instrument to be used and description of the population that will take part in the study.

3.2 Concepts, variables and contexts

To achieve this study's objectives, this section attempts to highlight the two main concepts that were previously discussed (chapter 2) in relation to the interactivity of learning systems. One, the 'Learning Interaction' concept, where there are three main categories or variables of CMLIs (Moore, 1989; Hillman et al, 1994; Moore and Kearsley, 1996), namely, Student-Information (S-I), Student-Student (S-S), and Student-Tutor (S-T). Two, the 'LS' concept including the Active-Reflective (AR) and Visual-Verbal (VV) dimensions of LSs (Felder and Silverman, 1988). This study explores the relationship between students' LSs and their attitude towards the 3-CMLIs. Consequently, contextual variables such as performance or learning outcome are not included in this research, as it does not investigate the effect of accommodating LSs on students' performance, but rather, focus on students’ LSs in relation to their attitudes towards different CMLIs that constitute essential part of the interactivity of learning systems. After all, performance can be a result of collective factors, some of which can be tangible and some are difficult to measure, that are not investigated in this research. Figure 3.1 represents the conceptual form of the hypothesis, while Figure 3.2 represents its operational form. Here the 3-CMLIs (S-I, S-S & S-T) represent the dependent variables, as this is the area of interest and problem that need to be investigated, a key variable in CML and an important factor that needs attention when designing ILSs in order to improve its interactivity design. On the other hand, the independent variables are LSs (AR & VV) as they are hypothesised or expected to account for the dependent variables' variance, and are closely related to the interactivity of learning systems, in terms of the attitude towards the use of different types of interactions and perception of their usefulness, in relation to the 3-CMLIs (see also chapter 2), as well as the way they are presented (multimedia design).
It will investigate the relationship in two phases and contexts (Figure 3.3), general and specific in order to further expose and contrast between different LSs' attitudes towards the 3-CMLIs that may be unclear or vague in general terms but clearer under specific contexts. The former is to try to explore students' general perception and actual use (voluntarily) without being influenced with particular factors such as the subject or the learning environment. The latter is to validate and explore whether the same LSs’ attitudes apply under more specific contexts (non-voluntarily) for different CMLIs. Phase one (main phase), looks at students' attitudes towards CMLIs in the context where students use traditional on campus lecture methods and have the choice of using CMLIs voluntarily (Voluntary Choice). For example, the student can choose to use e-mail for S-S and S-T interactions and the internet for S-I interaction through information search and/or download lecture slides using the internet. This is to obtain students' free opinions of such learning interactions and report (snap shot) their level of use, perception, and learning preference between traditional and CMLIs. Phase two (secondary phases), looking at more specific contexts where students have no choice but using CMLIs (Non-voluntary choice). One possible example, is a computer lab situation, to investigate whether students develop different attitude towards S-I interaction due to the specific task they have to achieve during the lab session. Another possible example is through the use of computer learning environments such as WebCT, where students may have to develop different attitudes due to lack of face-to-face interactions, particularly the S-S and S-T interactions. More details of the phases of the research will be described later in this chapter.
Chapter 3: Research Design and Initial Results

3.3 Research approach and methods

Human opinions and interpretations of computer systems are central to any IS research (Walsham, 2002), including education (Myers and Avison, 2002). Given the wide scope of IS field, there exist high diversity in IS research methods and approaches (Myers and Avison, 2002). According to Soltis (1992) there are “three major paradigms, or three different ways of investigating important aspects of education” (p620): 1) the positivist or quantitative paradigm, 2) the interpretive or qualitative paradigm, and 3) the critical theory or neomarxist paradigm. A mixed approach is adopted in this study incorporating both quantitative and qualitative research approaches, in order to provide a descriptive and exploratory picture of what is going on (a snapshot) in terms of identifying students’ LSs, proportion of each LS, use, and opinions towards the 3-CMLIs. The study is considered comparative in nature in terms of LSs to be investigate, adopts a survey method and focus on the relationship between LSs and students attitude towards the 3-CMLIs. It adopts ‘non-experimental’ method (Punch, 2003: pp2-3), through applying the logic of the experiment to the non-experimental research situation (look at the world as it is- no manipulation of variables). It focuses on small-scale and cross-sectional surveys (data are collected at one point in time) that are based on individual students as the unit of analysis (logic of the research is to investigate how individual students with different LSs vary on the different variables investigated) and built around the Index of LSs Instrument and self-reported questionnaires.

The rationale for proposing the mixed research approach is therefore, exploring, describing and searching for closer understanding of students participants (Marshall and Rossman, 1995),
encouraging students to express their opinion, feelings and reactions towards using CMLIs in genuine and existing educational settings, and not putting them under an artificial controlled environment and pressure, or imposing pre-conceived ideas from the researcher. For interactive learning research to progress, teachers and designers need new and deeper theoretical and empirical perspectives to guide them. Despite that this study looks at natural learning settings, or in other words it looks at the real world settings rather than artificial or controlled experimental settings that are imposed by the researcher, it however has some experimental nature in that it incorporates elements of empirical research of learners that may lead to design considerations or principles to support the development of interactive learning systems. The study is of descriptive and exploratory nature to clarify understanding of LSs (Robson, 1993), as well as an evaluative nature as it is designed to deal with complex human issues related to CML. It seeks to interpret and present meaningful constructions (Guba and Lincoln, 1989) related to CMLIs that are often shaped to a large extent by the values held by the actors (learners) in order to make sense of learning situations in which they find themselves. It is also has an ethnogenic dimension (Goetz and LeCompte, 1984) as it aims to represent the actors’ view of the world (CMLIs) in an undisturbed natural learning settings.

The use of survey method in this research is viewed as appropriate as the objectives related to collecting opinions from relatively diverse students, trying to explore possible relationships between the two concepts in order to inform the planning and design of ILSs. Survey questionnaires have been used in IS research and are regarded as appropriate for obtaining views at a particular point of time from which conclusions can be made regarding relationships that can exist in the past present or future (Galliers, 1992), and can be suitable where an exploratory and descriptive focus is required (Marshall and Rossman, 1995). Surveys will help to illustrate educational practice as it relates to students’ perceptions and learning preferences, examines the experiences of students with different learning preferences, in addition to helping in gaining a better understanding of students’ perception and needs. It is also suitable due to low cost, time factors and type of information required from students within a university environment.

Triangulation will be achieved through data collection from two different tools (successive questionnaires and observation). It is based on Cluster sampling (Walliman, 2001), by selecting clusters of units in a population and then performing the survey on each cluster. It involves successive sampling of units (or clusters); the units sampled progress from general to specific. The selection of clusters is based on some desired feature of the population learners, namely learners at
the beginning of a degree course, learners who have progressed through the course (phase one) and learners at specific learning settings (phase 2). Subjects of each unit are randomly selected from undergraduate and postgraduate students in a UK University doing computer degrees (for example, Information Systems, Computer Science, and Multimedia Computing). This because they consist of diverse students in terms of gender, age, and culture, however they all generally share three things in common, their desire to learn about computing, familiarity with basic aspects of computers and the internet, and have access to both computers and internet. This is essential in order to control or eliminate factors related to negative desire or intention to use CMLIs.

3.4 Phases of the research

In order to answer the research questions outlined above, the data collection process has been divided into two phases (Figure 3.4). Phase one deals with students' general perception and attitude towards CMLIs (or voluntary based choice of CMLIs). Phase two deals with students' perception and attitude in two specific settings (or non-voluntary based choice of CMLIs).

![Figure 3.4 Phases of data collection](image)

3.4.1 Phase one

This phase is concerned with part one of the study related to students' general attitude towards voluntary based choice of CMLIs. The study examines undergraduate Levels one and two (L1 & L2) taking a computer related degree in Information System or computer science, and postgraduate students Masters Level (ML) taking MSc computer related degrees in Information Systems or Distributed Systems at Brunel University, UK. The research in this phase is based on three successive independent samples (series of cross-sectional surveys in which the same questions are
asked—where data are collected at a particular moment of time-snapshot), individual person as the
unit of analysis, small-scale, at 3 Levels of study (L1, L2, ML). Independent variables (IVs) are:
Visual-Verbal (VV) and Active-Reflective (AR) variables, dependent variables (DV) are the three
CMLIs (S-I, S-T and S-S). The same questionnaire is distributed randomly to the three study levels
(L1, L2, and ML) during contact time of the last two weeks of the autumn semester 2001/2002,
taking approx 15-20 minutes of the scheduled one-hour seminars or two hours lectures. Students are
informed that the research is being carried out to investigate students' LSs and their perception of
various features of Interactive Web/Computer-based technologies for supporting their learning, and
in order to do that, it is important to have an accurate understanding of learners' experiences and
preferences. They are also informed that information they provide will be treated as confidential.
However, students are encouraged to leave their names and e-mails for the purpose of further
research in the future.

3.4.2 Phase two
Phase one looks at general issues related to CMLIs with no reference to specific contexts, settings
or learning environments, particularly in relation to S-I. This phase however is concerned with the
second stage of the study to investigate students' perception and attitude towards two specific
education settings (non-voluntary based choice of CMLIs).

3.4.2.1 First setting (Computer Lab Environment)
A cross-sectional survey is used in this setting, small-scale, and built around a self-reported
questionnaire. The IVs or independent variables are: Visual and Verbal variables, DV or dependent
variable is S-I interaction. It particularly looks closely at S-I interaction. It aims to explore the
relationship between students' LSs (VV) and learning preferences through their learning of database
query languages: Query-By-Example (QBE) and Structured Query Language (SQL). It looks at
students' perceptions of learning a Database Management System (DBMS) that incorporates
different presentation styles. QBE incorporates a visual and graphical approach for accessing
information in a database through the use of query templates (Zloof, 1977). SQL, on the other hand,
is a textual based command language, which include definitional and manipulative command
statements (Connolly, 1999). A profile of LSs is drawn, and a comparison between students' perceptions in relation to learning these different query languages (SQL & QBE) is made. Students
taking part of this study have attended five lab sessions of database learning, hands-on experience
of query manipulation using both SQL and QBE languages. The purpose is to provide students with
the skills and abilities to make reasoned choices as to which problem-solving tools they should adopt according to their different needs, through using MS Access-2000 Database Management Systems (DBMS) as a practice ground for implementing database designs. QBE and SQL are both well-known data manipulation tools for retrieving information from relational database systems. This is to look for possible links between student LS and their choice between the two presentations in terms of use and perception, and whether there are other influences that should be considered (eg difference between the two groups and subject knowledge). With such a variety of backgrounds in analysis and problem solving, and programming skills, it is important to make available a variation of material to accommodate such differences. Teaching QBE is the introductory part of the lab sessions, followed by teaching SQL to develop more complex queries as course material dictates in the later stages. The first stage of the lab sessions deal with familiarizing the students with the DBMS and the principles of creating tables, forms, and queries using QBE. In the second stage SQL is used, since the introduction and features of the DBMS becomes a relatively low level task, and thus students can concentrate on learning the notation. This is to provide efficiency in terms of avoiding repetitive teaching of foundational DB concepts, and in pedagogical terms, to provide students with the foundations of DB concepts first in order to better grasp their generic principles independent of the features of a particular language. This is to help the retention of high-level, adaptable design patterns rather than for the memorization of specific, low-level notations. However, such organization of activities raises several questions: one, do Visual and Verbal LSs have an effect on their preference and perception of using both query tools? If so to what extent is that recognized? Two, how easy or difficult do students from different LSs find learning both QBE and SQL. Do other factors influence students' preference and perception of both languages?

The population of the study are postgraduate students taking computer related degrees at Brunel University, UK. Prior to filling the questionnaires, learners are informed of the research objectives and potential benefit for learners and lecturers. Questionnaires are anonymous, in order to encourage students to supply such details as freely and accurately as possible. The questionnaires are distributed randomly during contact time of the last two weeks of the autumn semester 2002/2003; taking approx 5-10 minutes of the scheduled two-hour lectures.

3.4.2.2 Second setting (WebCT learning environment)
The second setting and final part of the study includes observation in addition to cross-sectional survey, small-scale, built around a self-reported questionnaire in the presence of the researcher. IVs include the Active and Reflective variables, while the DVs include the three...
CMLIs (S-I, S-T, S-S). The course of study is based on ‘Systems Development’ module, a newly developed module as part of a MSc degree in Multimedia Computing at Brunel University. The teaching is based on virtual lectures rather than traditional lectures which are available to students on their WebCT home page and CD-ROM. This phase includes a survey that includes the Index of LSs for the Active-Reflective dimension and self-reported questionnaires (Appendix 5) of a group of ML students. The data gathering is carried out in the first and last two weeks of the spring semesters that comprised the academic year 2002/03. Prior to filling the questionnaires, learners are informed of the research objectives and potential benefit for learners and lecturers. The questionnaires are distributed randomly during contact time of the first two weeks of the spring semester, taking approx 5 minutes of the scheduled one-hour seminars. The observation involved collecting statistics provided by the WebCT system during all semester concerned to investigate frequency of access, number of messages sent to discussion board, and number of e-mails to tutor.

3.5 Survey questionnaires

The survey questionnaires (Appendixes 1, 3, 4, and 5) include three main sections. One, LSs’ instrument test. Two, self-reported questionnaire using a 4-point Likert-type of students’ use and perceptions scale. Three, demographic questions. The self reported questionnaires adopted standard survey research guidelines (McNeil, 1990) and pre-tested at a local level amongst students. A pilot was conducted on six students of the type who would feature in the sample. The information collected from the pilot suggested that the questionnaire was generally viable for its purpose, with only few changes relating to wordings and style.

3.5.1 LSs instruments

Several instruments have been developed to identify individual LSs, some of which have been reviewed and evaluated (Riding and Rayner, 1998; Zywno, 2003). For example, the LSI ‘LS Inventory’ (Kolb, 1985), the LSQ ‘LS Questionnaire (Honey and Mumford, 1986), The MBTI ‘Myers-Briggs Type Indicator’ (Lawrence, 1994; McCaulley, 1990; Myers and McCaulley, 1985), the ASI ‘Approaches to Study Inventory’ (Entwhistle, 1979; 1981), and the ILS ‘Index of LS’ (Felder and Silverman, 1988; Felder and Soloman, 1999). Whilst all the above models and instruments may have some relevance to ILSs, none of them are perfect (Curry, 1990), however they give an opportunity to learn about the student’s preferred LS. Felder and Soloman’s (1999) Index of LSs, which is based on Felder and Silverman’s LS model (1988) and synthesised from findings of several research studies in LSs. Furthermore, its ease of use (Montgomery, 1995), clarity
of questionnaire (Zywno, 2002, 2003), and the variety of information available that covers several aspects of it had added value. The instrument can be used at the start of a period of learning (semester/term) and is applicable to online courses. The instrument is used in several studies (Rosati, 1999; Montgomery, 1995; Kuri and Truzzi, 2002; De Vita 2001; Sabry and Baldwin, 2003), evaluated and argued to be appropriate and statistically acceptable tool for characterising learning preferences (Zywno, 2003). The instrument also addresses the interactivity issues that are fundamental to the successful use of ILSs, namely, the AR and VV dimensions in terms of the three CMLIs. Felder and Soloman's (1999) Index of LSs, which is based on Felder and Silverman's LS model (1988), measures these two dimensions in addition to others, through a 44-element questionnaire (11 elements to measure each dimension) that develops the preference profile of the learner (Appendix 1). Each LS measured by the instrument ranges between three strength levels (see Table 3.1) using a scoring sheet provided by the instrument (Appendix 2).

<table>
<thead>
<tr>
<th>Strength Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong preference (STNG)</td>
<td>May have difficulties learning if the teaching style used does not accommodate his/her preferred LS of that dimension</td>
</tr>
<tr>
<td>Moderate preference (MOD)</td>
<td>Learns more easily using a teaching style that accommodates the preferred LS of that dimension.</td>
</tr>
<tr>
<td>Mild preference (MLD)</td>
<td>Essentially well balanced (i.e. the learner will have no learning difficulties if the teaching style used goes towards each side of that dimension.</td>
</tr>
</tbody>
</table>

Table 3.1 Strength level scale (based on Felder and Soloman, 1999)

For each LS dimension the Instrument provides two answers, each answer indicates one of the LSs of the dimension where there is no right or wrong answers. For example one of the 11 questions that measures whether the student is Active or Reflective in terms of understanding the learning material, the student is given the choice whether s/he prefers to try things out (Active LS) or think it through first (Reflective LS). If the answer is the former, this will count as one score towards the Active Style, and if the latter, this will count as one score towards the Reflective Style. An example of the 11 questions that measures the VV dimension, the student is given the choice whether s/he prefers to see new information as picture, diagrams, graphs (Visual LS) or as written or verbal information (Verbal LS).

LSs results are obtained through adding scores using a scoring sheet (Appendix 2) to determine different strength scales (mild, moderate, and strong). To identify whether the student is one or the other style of each dimension, the total number of choices for each style is added, then followed by subtracting the smaller from the larger one. This indicates the student’s style for that particular
dimension. The strength level of the style then is decided according to the result. If the score is 1-3, the student has a mild preference for one or the other style of the dimension but essentially well balanced. If the score is 5-7, the student is then has a moderate preference for one style of the dimension of the scale and will learn more easily in a teaching environment, which favors that dimension. Finally, If the score is 9-11, the student has a strong preference for one style of the dimension of the scale. In this case the students may have real difficulty learning in an environment, which does not support that preference.

3.5.2 Self reported questionnaires
The self reported questionnaire (Appendix 3) consists of questions constituting three sections. The first section is concerned with students' learning preferences. Second, is concerned with students' background. Third, includes personal information. The first section consists of questions to explore students 'use', 'perception', and 'learning preferences' in terms of the 3- CMLIs explained in both chapters one and two. For example in terms of 'use' students are asked to indicate whether they use e-mail to communicate/interact with their peers for group work (S-S) and with lecturer/tutor (S-T) frequently, regularly, sometimes or not at all. In terms of 'perception' students are asked to indicate whether they think using e-mail to communicate with their peers for group work (S-S) and with lecturer/tutor (S-T) are important for their learning, whether they agree, neither agree or disagree, disagree, or do not know. In terms of S-I 'use' students are asked to indicate whether they use the internet to download/retrieve subject material and the search engines to research/collect data to help with their assignment/coursework frequently, regularly, sometimes or not at all. They are also asked whether they 'agree', 'neither agree nor disagree', 'disagree', or 'do not know', that using the internet and search engines to research/collect data is helpful for their learning and assignment/coursework. This section also includes questions to explore 'learning preferences'. For example, in terms of choice between attending a face-to-face lecture (traditional) or alternatively watching it virtually (on the Web). The second section contains questions to explore background information such as computer and Internet background excellent, good, and reasonable or beginner. The third section constitutes personal information such as year of study, gender, age, and English language fluency. The data collected from both Felder and Soloman (1999) Index of LSs Instrument and learning preferences questionnaire are loaded into the SPSS® and the relationship between them is drawn using the SPSS® cross tabulation facilities and Chi-Square statistical test. The results and findings are then to be represented along with a summary of the most meaningful results of the survey in chapters four and five.
For phase two of the research, the questionnaires target two different settings, the first is a computer lab environment and the second is WebCT learning environment. Details of both settings are described in more details in the following section. The questionnaire for the first setting (Appendix 4) consists of two parts, the first part is the Felder and Soloman (1999) Index of LSs concerned only with diagnosing the Visual-Verbal Styles as the investigation will only explore the S-I interaction in terms of different presentation styles, and the second part is a self reported questionnaire consisted of 10 questions concerned with the use of different presentations (textual and graphical), perception of their use and easiness/difficulties, background and personal information. The questionnaire for the second setting (WebCT Learning Environment) consisted of two parts (Appendix 5), the first part is the Felder and Soloman (1999) Index of LSs concerned only with diagnosing the Visual-Verbal and Active-Reflective Styles as the investigation will explore the 3-CMLIs, and the second part is a self reported questionnaire consisted of 17 questions concerned with 'use', 'perception', Learning Preferences, background and personal information. The second setting (WebCT Learning Environment) also include observation of the statistics provided by the system to investigate frequency of access, number of messages sent to discussion board, and number of e-mails to Tutor. Similar to the first phase, data collected from both Felder and Soloman (1999) Index of LSs Instrument and Learning Preferences questionnaire are loaded into the SPSS® and the relationship between them are drawn using the SPSS® cross tabulation facilities and Chi-Square statistical test. The results and findings are then represented along with a summary of the most meaningful results of the survey in chapters four and five. Furthermore, a general comparison will be made between the two phases in terms of LSs using the Index of LSs and self reported questionnaires, using a subset of questions related to high/low use and perception of usefulness of the 3-CMLIs. Students' reported prior knowledge would also be taken into consideration for this comparison.

3.6 Initial results of population composition

For phase one, the population consists of diverse students in terms of gender, age, and high percentage of who are of non-English mother tongue, however they all share one thing in common, their desire and motivation to learn about computing. They are also chosen from the Information Systems and Computer Science department, as it is believed that they would be generally motivated and familiar with using computers and the Internet. Out of 242 questionnaires distributed, 189 where completed, a response rate of 78%. As far as Level one (L1) is concerned, out of 112 questionnaires distributed, 96 where completed, a response rate of 86%, while in Level two (L2),
out of 80 questionnaires, 52 where completed, a response rate of 65%, and regarding the MSc level (ML), out of 50 questionnaires, 41 where completed, a response rate of 82%.

Despite that, this research does not investigate extraneous (Saunders et al., 2000) or attribute variables (Dillman, 1978) such as the influences of other individual differences (such as gender, first language and age) on LSs, it is thought to be essential to attempt to try to understand more about the main differences between the three groups or levels in these terms in addition to computer and internet background, due to their possible influence on LSs as mentioned previously in the literature. Based on the self-reported information gathered from the questionnaire, table 3.2 shows a comparison between the three levels as follows:

<table>
<thead>
<tr>
<th>Differences /levels</th>
<th>Age %</th>
<th>E. Language%</th>
<th>C. Background %</th>
<th>I/W. Background %</th>
<th>Gender %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18-20</td>
<td>21-Over</td>
<td>English</td>
<td>Others</td>
<td>Ex.-Gd</td>
</tr>
<tr>
<td>L1</td>
<td>72</td>
<td>28</td>
<td>33</td>
<td>67</td>
<td>77</td>
</tr>
<tr>
<td>L2</td>
<td>52</td>
<td>48</td>
<td>52</td>
<td>48</td>
<td>79</td>
</tr>
<tr>
<td>ML</td>
<td>0</td>
<td>100</td>
<td>44</td>
<td>56</td>
<td>68</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>49</td>
<td>41</td>
<td>59</td>
<td>76</td>
</tr>
</tbody>
</table>

Table 3.2 Comparison between the three levels.

As an initial comparison between the three levels, it worth noting here that due the time of the survey (i.e. the last 2 weeks of the first semester of the year 2001/2002), both L1 and ML are considered to be at the early stage of their degree, while L2 is at the middle stage of the degree. Each of the three levels included a higher percentage of male students than female students (see table 3.2 & Appendix 6). In terms of order, level one (L1) has the highest percentage of male students (78%) followed by level two (L2) 75% and then the MSc level (ML) 58.5%. The ML has the highest percentage of female students (41.5%), followed by L2 and then L1. As might have been expected, L1 included the highest percentage of students who are under 21 years old, while ML included the highest percentage of students who are over 21 years old. L2 falls somewhere between the two levels. In terms of general computing and Internet background the younger population (18-20) displayed generally higher level compared to older population. In terms of order, the results also show that L2 displayed the highest percentage of students who possess higher level of both Internet/Web and computing background, followed by L1 and ML. Looking in more depth to the results, it was found that L1 younger students have higher level of computer and Internet
background (82.61%) compared with older students (62.96%-66.67%). L2 included a higher percentage of students whose native language is English (52%), while L1 included the highest percentage of students whose native language is not English (67%). ML falls somewhere between the two levels.

For phase two, first setting (Computer Lab Environment), out of 58 students present, 46 filled the questionnaire, 35 of which were completed, response rate of 60%. The sample included 23% female and 77% male students. 60% of the sample is students whose first language is English, and 40% who are not (Appendix 7). It included students registered on two-degree programmes, that is, the MSc Information Systems-IS (57%) and the MSc Distributed Systems-DS (43%). In terms of computing background including database and query languages, Table 3.3, shows that high percentage of the population (91%) had higher (good-excellent) general computing background before starting the module. However, the percentage of 'high-level' background in SQL is higher (60%) than in QBE (37%).

<table>
<thead>
<tr>
<th>Computing Background</th>
<th>General Computing (e.g., Word processing, spreadsheet)</th>
<th>SQL</th>
<th>QBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>High level (good-Excellent)</td>
<td>91%</td>
<td>60%</td>
<td>37%</td>
</tr>
<tr>
<td>Low level (beginner)</td>
<td>9%</td>
<td>40%</td>
<td>63%</td>
</tr>
</tbody>
</table>

Table 3.3 Students background before starting the module

In terms of IS students, high percentage of the population (85%) had higher (good-excellent) general computing background before starting the module. However, the percentage of 'high-level' background in SQL is higher (55%) than in QBE (35%). In terms of DS students, very high percentage of the population (100%) had higher (good-excellent) general computing background before starting the module. However, the percentage of 'high-level' background in SQL is higher (66.67%) than in QBE (40%), which is higher than IS students.

For phase two, second setting (WebCT learning environment) 12 students completed the questionnaire; the population consisted of 58.3% male and 41.7% female. In terms of age, 16.7% are 21 years old or under, 83.3% are over 21 years old. 75% had English language as first language and 25% others. In terms of general computer and Internet background all reported between excellent and good level and no beginners.
3.7 Summary

This chapter described the planning of the research phases, including description and details of the questionnaires/observation plan, the LS instrument to be used to measure students' different LSs, and description of the population in question of the three phases. It also discussed the mixed research approach and methods used in the study and the rationale for the use of the survey method to answer the research questions. It explained the two phases of the research, where phase one deals with students' general perception and attitude towards CMLIs (or voluntary based choice of CMLIs). Phase two deals with students' perception and attitude in two specific settings (or non-voluntary based choice of CMLIs). This chapter also presented the background of the population composition, which demonstrated differences in terms of gender, age and first language; however it reported generally high level in computer and Internet background. The next chapter (chapter 4) will present the results of the main stage of the research (phase one), which is concerned with students' attitude towards voluntary based choice of CMLIs. It will include three successive survey questionnaires distributed to three study levels including undergraduate levels one and two (L1 and L2) and postgraduate (ML).
Chapter 4- Phase One Results

4.1 Introduction

Chapter three described the planning of the research phases, including description and details of the questionnaires, observation, the Index of LSs instrument, and population description of the three phases. It also discussed the mixed research approach and methods and the rationale for the use of the survey method to answer the research questions. It explained the two phases of the research, where phase one dealt with students' general perception and attitude towards CMLIs (or voluntary based choice of CMLIs), while phase two dealt with students' perception and attitude in two specific settings (or non-voluntary based choice of CMLIs). It presented the background and population composition, which demonstrated differences in terms of gender, age and first language. It also reported generally high level in computer and Internet background. This chapter presents the results of the main stage of the research (phase one), which is concerned with students' attitude towards CMLIs (voluntary choice). It includes three successive survey questionnaires that are distributed to three study levels including undergraduate levels one and two (L1 and L2) taking a computer related degree in Information System or Computer Science, and postgraduate students (ML) taking computer related degrees in Information Systems or Distributed Systems at Brunel University, UK. The surveys include two main sections, one includes the Index of LSs questionnaire, which will be analysed using a scoring sheet, and the other includes a self-report questionnaire to find out students' attitudes towards different CMLIs in terms of use, perception and learning preference. A profile of students' LSs for each level is then drawn out in addition to their attitude towards CMLIs, and comparisons between them.

4.2 Outcome results of Felder’s Index of LSs

4.2.1 Visual-Verbal dimension

Overall the percentage of Visual students is far higher (80.4%) than Verbal students (19.6%). In terms of the breakdown of each style (i.e. mild, moderate, and strong), 39.7% of the population exhibited a mild preference, 26.5% of which towards Visual and 13.2% towards Verbal style,
while 60.3% exhibited stronger tendencies (ranging from moderate to strong), 53.9% towards Visual and 6.4% towards Verbal (Figure 4.1).

![VIS.VRB](image)

Figure 4.1 Overall profile of LSs (VV dimension)

In terms of each group, learners from the three levels clearly exhibited a higher tendency towards Visual LS (76-83%) rather than the Verbal LS (17-24%). Despite the difference between the levels being quite narrow, it is noticeable that the tendency towards visual presentation gets less the higher the level becomes, and vice versa, the Verbal style increases as the level goes up (Figure 4.2).

![Figure 4.2 Overall comparisons between the 3 levels (VV)](image)

This was also demonstrated through using the mean percentage calculation, which indicates that the mean percentage of the three strength levels for Visual students is far higher than Verbal students. However, there is a clear gradual decrease of the percentage of Visual students as the
level of study gets higher, and also a gradual increase in the percentage of Verbal students as the level of study gets higher (Appendix 8- Figure A4.1). In terms of strength level (Visual-strong), L1 scored the highest, followed by L2, and then ML. In terms of Visual-moderate, again L1 scored the highest, followed by ML, and then L2. In terms of Visual-mild, L2 scored the highest, followed by ML, and then L1. In terms of Verbal-strong, L1 scored the highest, followed by L2, and then ML. In terms of Verbal-moderate, ML scored the highest, followed by L2, and then L1. In terms of Verbal-mild, ML scored the highest, followed by L2, and then L1 (Appendix 8- Figure A4.2).

In terms of L1 breakdown of each style (i.e. mild, moderate, and strong), 32% of the population exhibited a mild preference, while 68% exhibited stronger tendencies (ranging from moderate to strong). In terms of L2 breakdown of each style, 50% of the population exhibited a mild preference and 50% exhibited stronger tendencies. In terms of ML breakdown of each style, 44% of the population exhibited a mild preference, while 56% exhibited stronger tendencies. In comparison, L1 has the highest percentage of learners with strong preference, followed by ML, then L2 (Figure 4.3). Also, L2 has more balanced percentage of learners with strong preference, followed by ML, then L1. ML seems to occupy somewhere between both L1 and L2, it is closer to L1 in terms of the higher percentage of learners with strong LS preference.

![Figure 4.3 Overall strength level comparisons between the 3 levels (VV)](image)

4.2.2 Active-Reflective dimension

Overall the percentage of Active students is higher (63.5%) than Reflective students (36.5%). In terms of the breakdown of each style (i.e. mild, moderate, and strong), 62.5% of the population exhibited a mild preference, 37.6% Active and 24.9% towards the Reflective style, while approx
37.5% exhibited stronger tendencies (ranging from moderate to strong), 25.9% towards Active and 11.6% towards Reflective (Figure 4.4).

![ACT.REF](image)

**Figure 4.4 Overall profile of LSs (AR)**

In terms of each group, learners from the three levels clearly exhibited a higher tendency towards Active LS (62-65%) rather than the Reflective LS (35-39%). Despite the difference between the levels being quite narrow, it is noticeable however that the difference between L1 and ML is narrower compared with L2 (Figure 4.5).

![Figure 4.5 Overall comparisons between the 3 levels (AR)](image)

This was also demonstrated through using the mean percentage calculation, which indicates that the mean percentage of Active students is higher than Reflective students at all levels. However, there is a clear gradual increase of the percentage of Reflective students as the level of study gets
higher, and that L1 has highest Active students’ percentage. It is also noticeable, that gap between Active students amongst all levels is narrow. Also, ML students have the highest mean percentage of Reflective students followed by L2, then L1 (Appendix 8- Figure A4.3). In terms of strength level (Active-strong), L1 scored the highest, followed by L2, and then ML. In terms of strength level (Active-moderate), ML scored the highest, followed by L1, and then L2. In terms of strength level (Active-mild), L2 scored the highest, followed by L1, and then ML. On the other hand, Reflective-strong students, L2 scored the highest, followed by L1, and then ML. In terms of strength level (Reflective-moderate), L2 scored the highest, followed by L1, and then ML. In terms of strength level (Reflective-mild), ML scored the highest, followed by L1, and then L2 (Appendix 8- Figure A4.4).

In terms of L1 breakdown of each style (i.e. mild, moderate, and strong), 61.5% of the population exhibited a mild preference, while 38.5% exhibited stronger tendencies (ranging from moderate to strong. In terms of L2 breakdown of each style, 65.3% of the population exhibited a mild preference and 34.7% exhibited stronger tendencies. In terms of ML breakdown of each style, 61% of the population exhibited a mild preference, while 39% exhibited stronger tendencies. In comparison, ML and L1 have the highest percentage of learners with strong preference, followed by L2 (Figure 4.6). Also, L2 has more balanced percentage of learners with mild preference, followed by L1 and ML. ML seems to be closer to L1 in terms of the higher percentage of learners with strong LS preference, and percentage of mild students.

Figure 4.6 Overall strength level comparison between the 3 levels (AR)
4.2.3 Relation between the two dimensions

Overall the outcome analysis of the index of LSs showed that Visual students occupy very high proportion compared with all the other styles, with Active students second, followed by Reflective and then Verbal students. A high proportion of Visual students have stronger tendency towards the style, followed by Active, Reflective and then Verbal students (Table 4.1).

<table>
<thead>
<tr>
<th>LS</th>
<th>Overall Percentage</th>
<th>Stronger tendency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>80.4%</td>
<td>53.9%</td>
</tr>
<tr>
<td>Active</td>
<td>63.5%</td>
<td>25.9%</td>
</tr>
<tr>
<td>Reflective</td>
<td>36.5%</td>
<td>11.6%</td>
</tr>
<tr>
<td>Verbal</td>
<td>19.6%</td>
<td>6.4%</td>
</tr>
</tbody>
</table>

Table 4.1 Relationship between the two dimensions.

Figure 4.7 displays that Visual-Active students occupy higher percentage of all the three levels, followed by vis-ref students.

It also displays that Visual-Active students occupy higher percentage of the L1 sample (57.29%) in comparison with Visual-Reflective students (26.04%). Verbal-Reflective students occupy higher percentage of the sample (9.38%) in comparison with Verbal-Active students (7.29%). It also shows that Visual-Active students occupy higher percentage of the L2 sample (50%) in comparison with Visual-Reflective students (28.85%). Verbal-Reflective students occupy lower percentage of the sample (9.62%) in comparison with Verbal-Active students (11.54%). Similarly, Visual-Active students occupy higher percentage of the ML sample (46.34%) in comparison with Visual-Reflective students (29.27%). Verbal-Reflective students occupy lower percentage of the sample (7.32%) in comparison with Verbal-Active students (17.07%).
4.3 Relationship between LSs and CMLIs

4.3.1 Student-information interaction (S-I)

Use of S-I

In terms of the ‘Use of S-I’, Students were asked to indicate whether they use the Internet for S-I interaction frequently, regularly, sometimes, or not at all: ‘I use the Internet to download/retrieve subject material and research/collection data to help me with my assignment/coursework’. Overall students from all levels showed frequent-regular level of use (80%) and high perception of its usefulness (89%). ML displayed the highest level of use and perception of its usefulness, followed by L1, while L2 displayed the lowest level (Figure 4.8).

![Figure 4.8 Comparison between the 3 levels in relation to use of S-I interaction](image)

Visual students show higher use towards this type of interaction than Verbal students (Table 4.2). Moreover, in terms of strength level, Visual students (moderate-strong) scored 83.33%, which is much higher than Verbal students who scored 66.67%.

<table>
<thead>
<tr>
<th></th>
<th>Lower use</th>
<th>Low use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual</td>
<td>Higher use</td>
<td>High use</td>
</tr>
<tr>
<td>Overall</td>
<td>Strong LS</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.2 Overall students’ use of S-I interaction (VV)

Similarly, Active students show higher use towards this type of interaction compared with Reflective students (Table 4.3). Moreover, in terms of strength level, Active students (moderate-strong) scored 79.27%, which is much higher than Reflective students who scored 54.55%.
Chapter 4: Phase One Results

Table 4.3 Overall students' use of S-I interaction (AR)

<table>
<thead>
<tr>
<th>Reflective</th>
<th>Lower use</th>
<th>Low use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>Higher use</td>
<td>High use</td>
</tr>
</tbody>
</table>

Furthermore, there is statistical significant evidence for an association between AR strong end of the scale, and high/low use of S-I ($p < 0.01, X^2=8.1$). In other words, the proportion of Active LS with high use differs significantly from the proportion of Reflective with high use. Therefore, a relationship exists between AR LSs and use of S-I (Appendix 9).

In terms of each level, similar to the overall picture previously mentioned, L1 Visual students show a slightly higher percentage of S-I use (79.75%) compared to Verbal students (75.00%). In terms of strength level Visual students show a stronger tendency (59.49%) for using this type of interaction compared with Verbal students (18.75%), which is approx 3 times more. One thing is quite noticeable here, namely that a Verbal-mild student scored high (56.25%) compared to Visual-mild (20.25%) which is approx 3 times higher (Appendix 8- Table A4.1). In terms of L2, overall, L2 Visual students show higher percentage of S-I use (70.73%) compared to Verbal students (63.64%). In terms of strength level (Appendix 8- Table 4.2) Visual students show stronger tendency (43.90%) for using this type of interaction compared with Verbal students (18.18%), which is approx just over 2 times. Similar to L1, Verbal-mild students scored high (45.45%) compared to Visual-mild (26.83%). ML Visual students show higher percentage of S-I use (96.77%) compared to Verbal students (90.00%). In terms of strength level Visual students show stronger tendency (64.52%) for using this type of interaction compared with Verbal students (30.00%). Similar to L1 and L2, Verbal-mild students scored high (60%) compared to Visual-mild (32.26%), which is approx 2 times higher (Appendix 8- Table A4.3).

On the other hand, overall L1 Reflective students show higher percentage of S-I use (82.35%) compared to Active students (77.05%). However, in terms of strength level (Table 4.4), Active students show a stronger tendency (37.7%) for using this type of interaction compared with Reflective students (23.53%). This contradiction appears to be due to the fact that Reflective-mild students scored higher level of use (58.82%) compared with Active-mild students (39.34%).
Chapter 4: Phase One Results

Reflective

<table>
<thead>
<tr>
<th>Higher use</th>
<th>Lower use</th>
</tr>
</thead>
</table>

Active

<table>
<thead>
<tr>
<th>Lower use</th>
<th>Higher use</th>
</tr>
</thead>
</table>

Mild LS | Strong LS

Table 4.4 L1 students’ use of S-I interaction (AR)

L2 Active students show higher percentage of S-I use (81.25%) compared to Reflective students (50%). In terms of strength level (Appendix 8- Table A4.4) Active students show stronger tendency (18.75%) for using this type of interaction compared with Reflective students (10%). Also, Active-mild students scored higher level of use (62.5%) compared with Reflective-mild students (40%). ML Active students show a higher percentage of S-I use (100%) compared to Reflective students (86.67%). In terms of strength level (Appendix 8- Table A4.5) Active students show stronger tendency (50%) for using this type of interaction compared with Reflective students (13.33%). However, similar to L1, Reflective-mild students scored higher level of use (73.33%) compared with Active-mild students (50%)

Perception of S-I

Students where asked to indicate there perception of S-I interaction, whether they agree with the following statement, disagree, neither agree or disagree, or do not know:

‘Using search engines to research/collect data are very helpful for my assignment/coursework’. Overall, Visual students show higher preference (92.1%) towards this type of interaction (Table 4.5) than Verbal students (78.4%). However, in terms of strength level, Visual students show much higher preference (92.16%) towards this type of interaction than Verbal students (52.94%).

Table 4.5 Overall students’ perception of S-I interaction (VV)
Both Active and Reflective students show a similar preference towards this type of interaction (Table 4.6). However, strong-moderate Active students show a higher tendency towards this type of interaction (89.8%) than strong-moderate Reflective students (72.73%).

<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>Lower</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflective</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>High</td>
<td>Higher</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.6  Overall students' perception of S-I interaction (AR)

In terms of each level of study, overall, both L1 Visual and Verbal students scored high in their perception of the importance of S-I for their learning compared to the actual use pattern. However, overall Visual students showed a higher preference (96.20%) of use of this type of interaction compared to Verbal students (93.75%). In terms of strength level, Strong-Moderate students showed a higher preference (69.62%) of use of this type of interaction compared to Verbal students (31.25%), which is approx two times higher. However, Verbal-mild students showed a higher tendency (62.5%) than Visual-mild students (26.58%). In terms of L2, overall Visual students scored higher (85%) than Verbal students (45.45%). In terms of strength level, Visual strong-moderate students showed higher preference (50%) of use of this type of interaction compared to Verbal students (9.09%), which is approx five times higher. However, Visual-mild students showed slightly higher tendency (32.5%) than Verbal-mild students (27.27%). Both ML Visual and Verbal students scored high in their perception of the importance of S-I for their learning compared to the actual use pattern. This result is quite similar to L1. Overall Visual students showed higher preference (96.77%) of use of this type of interaction compared to Verbal students (90.00%). This is also indicated here in the strength level analysis as Visual students show stronger tendency (61.29%) compared with Verbal students (30%). However, Verbal-mild students scored higher (60%) than Visual-mild students (35.48%).

L1 Active and Reflective students scored high in their perception of the importance of S-I for their learning compared to the actual use pattern. However, overall Reflective students showed higher preference (100%) of use of this type of interaction compared to Active students (93.44%).
In terms of strength level Active students show a stronger tendency (42.62%) compared with Reflective students (26.47%). However, Reflective-mild students show a higher preference (73.53%) than Active-mild (50.82%).

Both L2 Active and Reflective students scored high in their perception of the importance of S-I for their learning compared to the actual use pattern. However, overall Active students showed higher preference (81.25%) of use of this type of interaction compared to Reflective students (68.42%). However, Reflective students with stronger tendency scored slightly higher (21.05%) than Active students with stronger tendency (18.75%). However, Active-mild students show higher preference (62.5%) than Reflective-mild (47.37%). Both ML Active and Reflective students scored high in their perception of the importance of S-I for their learning compared to the actual use pattern. However, overall Reflective students showed higher preference (100%) of use of this type of interaction compared to Active students (92.31%). In terms of strength level Active students show stronger tendency (46.15%) compared with Reflective students (20%). However, Reflective-mild students show higher preference (80%) than Active-mild (46.15%).

Comparison between LSs

Use of S-I

Despite the gap between all styles being narrow for this type of interaction, overall, both Visual and Active students scored the highest, followed by Verbal and Reflective (Appendix 8-Table A4.6). In terms of the Visual-Verbal dimension, there is an indication at all levels that there is high level of S-I use, with ML at the top followed by L1 and then L2 (Figure 4.9).

![Figure 4.9 Comparison between different levels' use of S-I interactions (VV)](image)

There are also some similarities existing between the strong end of the Visual style (moderate-strong) and the mild end of the Verbal style (Figure 4.10).
In terms of the Active-Reflective dimension, generally, all levels scored high level of S-I use, with ML at the top followed by L2 and then L1. However, L2 Reflective students scored the lowest use (Figure 4.11).

The mild end of the Reflective style, scored higher than the strong end of the Active style (mod-strong) in both L1 and ML, with L2 as an exception (Figure 4.12).
For L1, despite the gap between the different styles being quite narrow, Reflective students scored the highest (82.35%), followed by Visual students (79.75%), then Active students (77.05%), and Verbal students (75%). For L2, Active students scored the highest (81.25%), followed by Visual students (70.73%), then Verbal students (63.64%), and Reflective students (50%). For ML, despite that the gap between the different styles is narrow in terms of using S-I, Active students scored the highest (100%), followed by Visual students (96.77%), then Verbal students (90%), and Reflective students (86.67%). It is noticeable here that, Visual students are second amongst all the other LSs in their use of S-I, and that Active students are first in both L2 and ML, except L1 (Figure 4.13).

\[\text{Figure 4.13 Comparison between the 3 levels’ use of S-I interaction}\]

**Perception of S-I**

Despite the gap between all styles being narrow for this type of interaction, overall, Visual, Reflective and Active students scored the highest, followed by Verbal (Appendix 8-Table A4.7). In terms of strength levels of LSs, Visual students show stronger preference towards this type of interaction than Verbal students at all levels. There are also some similarities existing between the strong end of the Visual style (mod-strong) and the mild end of the Verbal style in both L1 and ML, except L2 (Appendix 8-Figure A4.5). Reflective students at L1 and ML scored higher than Active students, with the exception of L2 (Figure 4.14).

\[\text{Figure 4.14 Comparison between the 3 levels perception of S-I interaction (AR)}\]
The mild end of the Reflective style scored higher at all levels than the strong end of the Active style (mod-strong) (Figure 4.15).

For L1, despite the gap between the different styles being quite narrow, Reflective students scored the highest (100%), followed by Visual students (96.2%), then Verbal students (93.75%), and Active students (93.44%). For L2, Visual students scored the highest (85%), followed by Active students (81.25%), then Reflective students (68.42%), and Verbal students (45.45%). For ML, despite that the gap between different LSs is narrow, Reflective students scored the highest (100%), followed by Visual students (96.77%), then Active students (92.31%), and Verbal students (90%). It is noticeable here that, Visual students are second amongst L1 and ML, and that Active students are first in both L1 and ML, except L2 (Figure 4.16).
4.3.2 Student-Tutor interaction (S-T)

Use of S-T

Students were asked to indicate whether they use the Internet for S-T interaction frequently, regularly, and sometimes or none:

'I use e-mail to communicate/interact with my lecturer/tutor'

As a whole, 29% of students only make use of the Web (in term of frequent and regular use) for Student-Tutor interaction, which is considerably a low score compared with S-I. In terms of year of study, generally, all years achieved very close score (27-30%). However, L1 students achieved the highest score (30%), while ML achieved the lowest score (27%). L2 score (29%) was between L1 and ML (Appendix 8-Table A4.8). Visual students show higher use (30.67%) towards this type of interaction than Verbal students (21.62%). However in strength level, Visual students (moderate-strong) scored 31% which is much higher than Verbal students who scored 8.33% (Figure 4.17).

Similarly, Active students show higher use towards this type of interaction than Reflective students. However in strength level, Active students (mod-strong) scored 35.42%, which is much higher than Reflective students who scored 13.64% (Figure 4.18). However, there is no statistical significant evidence (Appendix 9B) for an association between AR strong end of the scale, and high/low use of S-T ($p > 0.05, \chi^2 = 3.5$).
Chapter 4: Phase One Results

Overall, L1 Visual students show much higher percentage of S-T use (34.62%) compared to Verbal students (6.25%). However, in terms of strength level, Visual students show much stronger tendency (25.64%) for using this type of interaction compared with Verbal students (0%) (Appendix 8- Table A4.9). For L2, overall Visual students show slightly higher percentage of S-T use (29.27%) compared with Verbal students (27.27%). In terms of strength level Visual students show much stronger tendency (17.07%) for using this type of interaction compared with Reflective students (0%). This is in a way similar to L1, but with a closer gap between the two LSs (Appendix 8- Table A4.10). ML (Appendix 8- Table A4.11), overall Verbal students show higher percentage of S-T use (40%) compared to Visual students (22.58%). However, in terms of strength level Visual students show slightly stronger tendency (12.90%) for using this type of interaction compared with Verbal students (10%). This is in a way different than L1, and L2. However, Verbal-mild students show higher use (30%) than Visual-mild students (9.68%) (Appendix 8-Table A4.12).

L1 Active students show much higher percentage of S-T use (38.33%) compared to Reflective students (14.71%). In terms of strength level, again Active students show much stronger tendency (18.33%) for using this type of interaction compared with Reflective students (0%) (Appendix 8-Table A4.13).

L2 Active students show much higher percentage of S-T use (37.5%) compared to Reflective students (15%). However, in terms of strength level (Appendix 8- Table A4.14) Reflective students show stronger tendency (15.%) for using this type of interaction compared with Active (9.38%). It is also noticeable here that Active-mild scored much higher (28.13%) than Reflective-mild (0%) which is not consistent with L1 students (Appendix 8-Table A4.15).
ML Reflective students show higher percentage of S-T use (40%) compared to Active students (19.23%). However, in terms of strength level (Appendix 8- Table A4.16) Active students show stronger tendency (11.54%) for using this type of interaction compared with Reflective students (0%). It is also noticeable here that Reflective-mild scored much higher (40%) than Active-mild (7.69%) (Appendix 8-Table A4.17).

Perception of S-T

Students were asked to indicate their perception of S-T interaction, whether they agree with the following statement, disagree, neither agree or disagree, or do not know: 'Using e-mail to communicate with my lecturer/tutor is important'

Overall, Visual students show slightly higher preference (69.3%) towards this type of interaction than Verbal students (62.2%). However, in terms of strength level, Visual students show much higher preference (73%) towards this type of interaction than Verbal students (50%) (Table 4.7).

<table>
<thead>
<tr>
<th>Verbal</th>
<th>Lower</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher</td>
<td>High</td>
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</table>

Overall Strong LS

Table 4.7 Overall students' perception of S-T interaction (VV)

Similarly, Active students show slightly higher preference (68.1%) towards this type of interaction than Reflective students (67.6%). However, in terms of strength level, Active students show much higher preference (75.51%) towards this type of interaction than Verbal students (45.45%) (Table 4.8).

<table>
<thead>
<tr>
<th>Reflective</th>
<th>Slightly Lower</th>
<th>Low</th>
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<tr>
<td>Slightly Higher</td>
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Overall Strong LS

Table 4.8 Overall students' perception of S-T interaction (AR)
In terms of L1, Visual students showed higher preference (67.09%) compared to Verbal students (62.5%). In terms of strength level analysis Visual students show stronger tendency (50.63%) compared with Verbal students (18.75%). However, Verbal-mild students showed much higher preference (43.75%) than Visual-mild students (16.46%), which is approx two times. (Appendix 8-Table A4.18). L2 Visual students showed much higher preference (80%) compared to Verbal students (45.45%). In terms of strength level Visual students show stronger tendency (45%) compared with Verbal students (9.09%). However, compared with L1, L2 has wider gap between the two styles (Appendix 8-Table A4.19). ML Verbal students showed higher preference (80%) compared to Visual students (61.29%). In terms of strength level however, Visual students show stronger tendency (48.39%) compared with Verbal students (20%). Generally, ML students seem to be closer to L1, in terms of the gap between the two styles; however ML students are more towards the Verbal style. However, Verbal-mild students showed much higher preference (60%) than Visual-mild students (12.90%), which is approx five times (Appendix 8-Table A4.20).

Overall L1 Active students showed higher preference (70.49%) compared to Reflective students (58.82%). In terms of strength level Active students show stronger tendency (36.07%) compared with Reflective students (5.88%). However, Reflective-mild showed stronger tendency (52.94%) compared with Active-mild (34.43%) (Appendix 8-Table A4.21). Overall L2 Reflective students showed higher preference (73.68%) compared to Active students (71.88%). In terms of strength level Reflective students show stronger tendency (31.58%) compared with Active students (15.63%) (Appendix 8-Table A4.22). Overall ML Reflective students showed higher preference (80%) compared to Reflective students (57.69%). In terms of strength level Active students show stronger tendency (38.46%) compared with Reflective students (13.33%). However, Reflective-mild students showed stronger tendency (66.67%) compared with Active-mild (19.23%) (Appendix 8-Table A4.23).

Comparison between LSs

Use of S-T

Despite that the gap between all styles is narrow for this type of interaction; overall, both Active and Visual students scored the highest, followed by Verbal and Reflective students (Figure 4.19). Compared with S-I, S-T is considerably a low score.
Overall, Visual students show higher use (30.67%) towards this type of interaction than Verbal students (21.62%). Regarding the comparison between the 3 levels (Figure 4.20), in terms of the Visual style, overall, L1 Visual students scored the highest score, followed by L2 and then ML. In terms of the Verbal style, ML students scored the highest, followed by L2, then L1. The gap between the two styles is at its closest at L2, and wider at L1 then ML.

In terms of strength level Visual students show the highest percentage of use, followed by L2, and then ML. Verb-mild students in both ML and L2 are higher than L1 in terms of their use of this type of interaction (Figure 4.21). Similarly, compared with S-I, S-T is considerably a low score.
Regarding the comparison between the 3 levels, in terms of the Active style, overall, L1 students scored the highest score, followed by L2 and then ML (Figure 4.22).

In terms of the Reflective style, ML students scored the highest, followed by L2, then L1. The gap between the two styles is at its closet at L2 and wider at L1 then ML (Figure 4.23). In terms of strength level L1 Active students show the highest percentage of use, followed by ML, and then L2. Active-mild students in both L1 and L2 scored higher use than Reflective-mild, while in ML Reflective-mild scored higher than Active-mild.
For L1, despite the gap between the Active and Visual style being quite narrow, Active students scored the highest (38.33%), followed by Visual students (34.62%), then Reflective students (14.71%), and Verbal students (6.25%). Similar to L1, L2 Active students scored the highest (37.5%), followed by Visual students (29.27%), however, Verbal students here scored higher (27.27%) than Reflective students (15%). ML students on the other hand, scored high in both the Reflective and Verbal styles (40%), and lower on the Visual then the Active styles (Figure 4.24).

**Perception of S-T**

Despite that the gap between all styles is narrow for this type of interaction, overall, both Visual and Active students scored the highest, followed by Reflective and Verbal students (Appendix 8-Table A4.24). In terms of students perception of this interaction, they scored quite moderate compared to S-I. Overall, Visual students show stronger preference (73%) towards this type of interaction than Verbal students (50%). Generally, ML students seem to be closer to L1, in terms of the gap between the two styles, however ML students are more towards the Verbal style.
terms of order, the highest Visual score was L2, followed by L1, then ML. The highest Verbal score was ML, followed by L1, then L2 (Appendix 8-Table A4.25).

Overall, Active students show stronger preference (73%) towards this type of interaction than Reflective students (50%). In terms of order, the highest Active score was L2, followed by L1, then ML. The highest Reflective score was ML, followed by L2, then L1 (Appendix 8-Table A4.26). For L1, despite that the gap between the different styles is generally narrow, Active students scored the highest (70.49%), followed by Visual students (67.09%), then Verbal students (62.5%), and Reflective students (58.82%). For L2, Visual students scored the highest (80%), followed by Reflective students (73.68%), then Active students (71.88%), and Verbal students (45.45%). For ML, despite that the gap between the different styles is generally close, both Reflective and Verbal students scored the highest (80%), followed by Visual students (61.29%), then Active students (57.69%) (Figure 4.25).

Figure 4.25 Comparison between the LSs' perception of S-T interaction (AR and VV)

4.3.3 Student-student interaction (S-S)

Use of S-S

Students where asked to indicate whether they use the Internet for S-S interaction frequently, regularly, and sometimes or none: ‘I use e-mail to communicate/interact with my peers in group work’. Overall, 54% only of all students’ frequent-regular level of use of Student-Student interaction, which is a higher score than S-T Interaction, but lower than S-I interaction. However, ML students achieved the highest score (63%), while L1 achieved the lowest score (50%). L2 score (58%) was somewhere in between ML and L1. The result shows an increase of frequent-regular use as level goes up (Figure 4.26).
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Overall, the level of use is very close. Despite that Verbal students show slight higher frequent-regular use towards this type of interaction than Visual students, Visual-strong/moderate students show higher level of use (63%) compared with Verbal students (50%) (Table 4.9).

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<th>Slightly Higher</th>
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<td>Visual</td>
<td>Slightly Lower</td>
<td>High use</td>
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<tr>
<td>Overall</td>
<td>Strong LS</td>
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Table 4.9 Students' use of S-S interaction (VV)

Active students show much higher use (64.10%) towards this type of interaction than Reflective students (39.13%). Similarly, this was demonstrated by Active-strong/moderate students who showed higher level of use (75%) compared with Verbal students (36.36%) (Table 4.10).

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<td>Overall</td>
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Table 4.10 Students' use of S-S interaction (AR)
Furthermore, there is statistical significant evidence (Appendix 9B) for an association between AR strong end of the scale, and high/low use of S-S ($p < 0.01$, $X^2=9.6$). In other words, the proportion of Active LS with high use differs significantly from the proportion of Reflective with high use. Therefore, a relationship exists between AR LSs and use of S-S.

L1 Visual students show higher percentage of S-S use (50.65%) compared to Verbal students (43.75%). In terms of strength level Visual students show much stronger tendency (41.56%) for using this type of interaction compared with Verbal students (18.75%), while Verbal-mild students scored higher (25%) than Visual-mild students (9.09%) (Appendix 8-Table A4.27). L2 Verbal students show higher percentage of S-S use (63.64%) compared to Visual students (56.10%). In terms of strength level however, Visual students show stronger tendency (39.02%) for using this type of interaction compared with Verbal students (18.18%), while Verbal-mild students scored higher (45.45%) than Visual-mild students (17.07%) (Appendix 8-Table A4.28). ML Verbal students show higher percentage of S-S use (70%) compared to Visual students (61.29%). However, in terms of strength level Visual students show stronger tendency (48.39%) for using this type of interaction compared with Verbal students (10%). Again here the Verbal style is higher than Visual, however when it comes to strength level, strong Visual scored higher percentage of use. There are also some similarities exist between the strong end of the Visual style (moderate-strong) and the mild end of the Verbal style, however this is higher than both L1 and L2. Verbal-mild students scored much higher (60%) than Visual-mild students (12.9%) (Appendix 8-Table A4.29).

On the other hand, L1 Active students show much higher percentage of S-S use (62.71%) compared to Reflective students (26.47%). This was demonstrated at all strength levels (i.e. strong, moderate, and mild). For example, in terms of Active-strong students show stronger tendency (37.29%) for using this type of interaction compared with Reflective students (8.82%) (Appendix 8-Table A4.30). L2 Active students show higher percentage of S-S use (65.63%) compared to Reflective students (45%). This was demonstrated at all strength levels (i.e. strong, moderate, and mild). For example, in terms of strength level Active students show a slight stronger tendency (18.75%) for using this type of interaction compared with Reflective students (15%) (Appendix 8-Table A4.31). ML Active students show slightly higher percentage of S-S use (65.38%) compared to Reflective students (60 %). In terms of strength level Active students show much stronger tendency (30.77%) for using this type of interaction compared with
Reflective students (13.33%). However, Reflective-mild students scored higher than Active-mild students (Appendix 8-Table A4.32).

**Perception of S-S**

Students where asked to indicate there perceptions of S-S interaction, whether they agree with the following statement, disagree, neither agree or disagree, or do not know:

‘Using e-mail to communicate with my peers in group work is important’

Overall, slightly more Visual students perceive this type of interaction as important compared with Verbal students. However, in terms of strength level, Visual-strong/moderate students scored much higher (80%) than Verbal-strong/moderate students (58.33%) (Table 4.11).

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<tr>
<td>Overall</td>
<td>Strong LS</td>
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Table 4.11 Comparison between students' perception of S-S interaction (VV)

On the other hand, slightly more Active students perceive this type of interaction as important compared with Verbal students. Similarly, in terms of strength level, Visual-strong/moderate students scored much higher (79.59%) than Verbal-strong/moderate students (68.18%) (Table 4.12).

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<td>Overall</td>
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Table 4.12 Comparison between students' perception of S-S interaction (AR)

Both L1 Visual and Verbal students scored high in their perception of the importance of S-S for their learning compared to the actual use pattern. However, overall Visual students showed
slightly higher preference (75.95%) compared to Verbal students (68.75%). In terms of strength level Visual students show stronger tendency (58.23%) compared with Verbal students (25%). However, Verbal-mild students' scored much higher (43.75%) than Visual-mild students (17.72%) (Appendix 8-Table A4.33).

L2 students scored high in their perception of the importance of S-S for their learning compared to the actual use pattern. However, overall Visual students showed higher preference (75%) compared to Verbal students (54.55%). In terms of strength level Visual students show much stronger tendency (45%) compared with Verbal students (9.09%). However, compared with L1, L2 has a wider gap between the two styles. However, Verbal-mild students' scored much higher (45.45%) than Visual-mild students (30%) (Appendix 8-Table A4.34). Both ML Visual and Verbal students scored high in their perception of the importance of S-S for their learning compared to the actual use pattern. However, overall Verbal students showed higher preference (90%) compared to Visual students (74.19%). In terms of strength level however, Visual students show much stronger tendency (51.61%) compared with Verbal students (20%). Generally, ML students seem to be closer to L1, in terms of the gap between the two styles; however ML students are more towards the Verbal style. However, Verbal-mild students' scored much higher (70%) than Visual-mild students (22.58%) (Appendix 8-Table A4.35).

On the other hand, both L1 Active and Reflective students scored high in their perception of the importance of S-S for their learning compared to the actual use pattern. However, overall Active students showed slightly higher preference (75.41%) compared to Reflective students (73.53%). In terms of strength level Active students show stronger tendency (37.7%) compared with Reflective students (17.65%). However, Reflective-mild students' scored higher (55.88%) than Active-mild students (37.7%) (Appendix 8-Table A4.36).

Both L2 Active and Reflective students scored high in their perception of the importance of S-S for their learning compared to the actual use pattern. However, overall Active students showed slightly higher preference (71.88%) compared to Reflective students (68.42%). In terms of strength level however Reflective students show stronger tendency (31.58%) compared with Reflective students (18.75%). However, Active-mild students' scored higher (53.13%) than Reflective-mild students (36.84%) (Appendix 8-Table A4.37). Both ML Active and Reflective students scored high in their perception of the importance of S-S for their learning compared to the actual use pattern. However, overall Reflective students showed slightly higher preference (80%) compared to Active students (76.92%). However, in terms of strength level Active students
show stronger tendency (38.46%) compared with Reflective students (20%). However, Reflective-mild students’ scored higher (60%) than Active-mild students (38.46%) (Appendix 8-Table A4.38).

**Comparison between the LSs**

**Use of S-S**

Overall, Active students scored the highest use of this type of interaction, followed by Verbal students, Visual students, and then the lowest score is by Reflective students (Figure 4.27).

![Figure 4.27 Comparison between the styles' use of S-S interaction (AR and VV)](image)

Overall, both Visual and Verbal styles scored high with ML at the top, followed by L2, then L1. However, Verbal students scored higher than Visual students at both the ML and L2, while L1 Visual students scored higher use of S-S than Verbal students (Figure 4.28).

![Figure 4.28 Comparison between the 3 levels use of S-S interaction (VV)](image)

In terms of strength level analysis, Visual students scored much higher than Verbal students with ML scoring the highest percentage of use, followed by L1 and then L2. However, Verbal-mild students scored higher than Visual-mild at all levels with ML highest score followed by L2, then L1 (Figure 4.29).
Overall, Active students scored higher than Reflective students at all levels with both L2 and ML at the top followed by L1 (Figure 4.30).

However, in terms of strength level analysis (Figure 4.31), Active-strong/moderate students scored much higher than Reflective students with L1 scoring the highest percentage of use, followed by ML and then L2. Active-mild students scored higher than Reflective-mild at both L1 and L2, while Reflective-mild students scored higher than Active-mild at ML.
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For L1, Active students scored the highest, followed by Visual students, then Verbal students and Reflective students. For L2, Active students scored the highest, followed by Verbal students, the Visual students, then Reflective students. For ML students on the other hand, Verbal students scored the highest use, followed by Active students, Visual students then Reflective students. It is noticeable here that Reflective students scored the lowest score at all levels (Figure 4.32).

\[
\text{Figure 4.32 Comparison between the 3 levels use of S-S interaction (AR and VV)}
\]

**Perception of S-S**

Overall, a high percentage of students prefer traditional learning methods rather than web based. However, a considerable percentage are more willing to have web-based learning augmented within traditional methods rather than having web-based learning as the dominant method. It was also noticeable that Visual students rather than Verbal students are willing to go for web-based learning. Despite that the gap between all styles is narrow for this type of interaction, overall, both Visual and Active students scored the highest, followed by Reflective and Verbal students. In terms of Visual-Verbal students perception of this interaction, they scored lower than S-I. Overall, L1 and L2 Visual students show higher preference towards this type of interaction than Verbal students; however ML Verbal students show higher preference than Visual students (Figure 4.33).

\[
\text{Figure 4.33 Comparison between the 3 levels perception of use of S-S interaction (VV)}
\]
In terms of strength level analysis, Visual students at all levels show stronger perception than Verbal learners. In the contrary, Verbal-mild students at all levels scored higher than Visual-mild students with ML students at the top, followed by L2, then L1. Generally, ML students seem to be closer to L1, in terms of the gap between the two styles; however ML students are more towards the Verbal style (Figure 4.34).

On the other hand, in terms of Active-Reflective students perception of this interaction, they scored lower than S-I. Overall, L1 and L2 Active students show slightly higher preference towards this type of interaction than Reflective students; however ML Reflective students show slightly higher preference than Active students (Figure 4.35).

In terms of strength level analysis, Active students of L1 and ML show stronger perception than Reflective learners, while the opposite is true for L2. On the other hand, Reflective-mild students of L1 and ML scored higher than Active-mild students, while the opposite is true for L2. Generally, ML students seem to be closer to L1, in terms of the gap between the two styles; however ML students are slightly more towards the Reflective style (Figure 4.36).
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For L1, the gap between the styles is very narrow indeed. However, Visual and Active students scored the highest, followed by Reflective and then Verbal students. For L2, the gap between the Visual and Active styles is narrow while the gap between them and other styles is wider. However, Visual students scored the highest, followed by Active students, Reflective students, then Verbal students. For ML students on the other hand, Verbal students scored the highest preference of use, followed by Reflective students, Active students then Visual students (Figure 4.37).

4.4 Overall comparison between the 3 interactions

Use of the 3-CMLIs

It is demonstrated that S-I interaction has the highest score at all levels in terms of frequency of use, followed by S-S, then S-T. However, in terms of S-I, overall Active and Visual students showed higher preference of use of this type of interaction compared to Verbal and Reflective students. However, it is noticeable also that the gap between the Active and Visual styles is narrow, as well as the gap between the Reflective and Verbal styles. In terms of S-T, overall Active and Visual students showed higher preference of use of this type of interaction compared to

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to Verbal and Reflective students. However, it is noticeable also that the gap between the Active and Visual styles is narrow, as well as the gap between the Reflective and Verbal styles. However, in terms of S-S, this is not the case, overall Active students showed highest preference, followed by Verbal and Visual students, then Reflective students who scored the lowest preference (Figure 4.38).

For L1, it is demonstrated that S-I interaction has the highest score at all levels in terms of frequency of use, followed by S-S, then S-T. However, in terms of S-I, overall Visual students showed higher preference of use of this type of interaction compared to Verbal students. However, it is noticeable also that the gap between them is narrow. In terms of S-T, overall Visual students showed higher preference of use of this type of interaction compared to Verbal students. However, it is noticeable also that the gap between them is wider compared with S-I interaction. In terms of S-S, overall Visual students showed higher preference than Verbal students, and the gap between them falls somewhere between S-I and S-T. In terms of strength level analysis, both Visual-moderate and strong levels scored higher than Verbal students for all interactions. In the contrary, Verbal-mild students scored higher than Visual-mild in both the S-I and S-S, with the exception of S-T interaction where Visual students scored slightly higher than Verbal students (Appendix 8-Figure A4.6).

For L2, it is demonstrated that S-I interaction has the highest score at all levels in terms of frequency of use, followed by S-S, then S-T. However, in terms of S-I, overall Visual students showed higher preference of use of this type of interaction compared to Verbal students. However, it is noticeable also that the gap between them is narrow. In terms of S-T, overall Visual students showed slightly higher preference of use of this type of interaction compared to Verbal students. However, it is noticeable also that the gap between them is narrower compared
with S-I interaction. In terms of S-S, overall Verbal students showed higher preference than Visual students. In terms of strength level analysis, both Visual moderate and strong levels scored higher than Verbal students for all interactions. In the contrary, Verbal-mild students scored higher than Visual students for all types of interactions (Appendix 8-Figure A4.7).

For ML, it is demonstrated that S-I interaction has the highest score at all levels in terms of frequency of use, followed by S-S, then S-T. However, in terms of S-I, overall Visual students showed higher preference of use of this type of interaction compared to Verbal students. However, it is noticeable also that the gap between them is narrow. In terms of S-T, overall Verbal students showed higher preference of use of this type of interaction compared to Visual students. However, it is noticeable also that the gap between them is wider compared with S-I interaction. Similarly, in terms of S-S, overall Verbal students showed higher preference than Visual students, however with a narrower gap than S-T interaction. In terms of strength level analysis, Visual-strong/moderate scored higher than Verbal students for all interactions. In the contrary, Verbal-mild students scored higher than Visual students for all types of interactions (Appendix 8-Figure A4.8).

With reference to the Active-Reflective dimension, L1, it is demonstrated that S-I interaction has the highest score at all levels in terms of perception of its use, followed by S-S, then S-T. However, in terms of S-I, overall Reflective students showed higher preference of use of this type of interaction compared to Active students. In terms of S-T, overall Active students showed higher preference of use of this type of interaction compared to Reflective students. However, it is noticeable that the gap between them is wider compared with S-I interaction. In terms of S-S, overall Active students showed higher preference than Reflective students, and the gap between them similar to S-T. In terms of strength level analysis, both Active-moderate and strong levels scored higher than Reflective students for all interactions. This also was true, with regards to Active-mild level, with the exception of S-I interaction where Reflective students scored higher than Active students (Appendix 8-Figure A4.9).

For L2, it is demonstrated that S-I interaction has the highest score at all levels in terms of frequency of use, followed by S-S, then S-T. However, in terms of S-I, overall Active students showed higher preference of use of this type of interaction compared to Reflective students. In terms of S-T, overall Active students showed slightly higher preference of use of this type of interaction compared to Reflective students. However, it is noticeable also that the gap between them is narrower compared with S-I interaction. In terms of S-S, overall Active students showed
higher preference than Reflective students. In terms of strength level analysis, both Active moderate and strong levels scored higher than Reflective students for all interactions. In the contrary, Reflective-moderate students scored higher than Active-moderate students for the S-T interaction (Appendix 8-Figure A4.10).

For ML, it is demonstrated that S-I interaction has the highest score at all levels in terms of frequency of use, followed by S-S, then S-T. However, in terms of S-I, overall Active students showed higher preference of use of this type of interaction compared to Reflective students. However, it is noticeable also that the gap between them is narrow. In terms of S-T, overall Reflective students showed higher preference of use of this type of interaction compared to Active students. In terms of S-S, overall Active students showed higher preference than Reflective students, however with a narrower gap than S-T interaction. In terms of strength level analysis, Active-strong/moderate scored higher than Reflective students for all interactions. In the contrary, Reflective-mild students scored higher than Active students for all types of interactions (Appendix 8-Figure A4.11).

**Perception of the 3-CMLIs**

It is demonstrated that S-I interaction has the highest score at all levels in terms of perception of use, followed by S-S, then S-T. This was similar to previous results of frequency of use; however it is noticeable that students' perception of them is higher than their actual use pattern. In terms of S-I, overall Visual, Reflective and Active students showed higher preference of use of this type of interaction compared to Verbal students. However, it is noticeable also that the gap between the Active, Reflective and Visual styles is narrow compared with Verbal students. This is also true with S-T and S-S (Figure 4.39).

![Figure 4.39 Comparison between the 3 interactions in terms of Perception (AR and VV)](image)
In terms of the Visual-Verbal dimension, L1, it is demonstrated that S-I interaction has the highest score at all levels in terms of perception of use, followed by S-S, then S-T. However, in terms of S-I, overall Visual students showed higher preference of use of this type of interaction compared to Verbal students. However, it is noticeable also that the gap between them is narrow. In terms of S-T, overall Visual students showed higher preference of use of this type of interaction compared to Verbal students. However, it is noticeable also that the gap between them is wider compared with S-I interaction. Similarly, in terms of S-S, overall Visual students showed higher preference than Verbal students, and the gap between them is wider than both S-I and S-T.

In terms of strength level analysis, both Visual-moderate and strong levels scored higher than Verbal students for all interactions. In the contrary, Verbal-mild students scored higher than Visual-mild in all interactions (Appendix 8-Figure A4.12).

For L2, it is demonstrated that S-I interaction has the highest score at all levels in terms of frequency of use, followed by S-S, then S-T. However, in terms of S-I, overall Visual students showed higher preference of use of this type of interaction compared to Verbal students. However, it is noticeable also that the gap between them is wider than L1 students. In terms of S-T, overall Visual students showed slightly higher preference of use of this type of interaction compared to Verbal students. However, it is noticeable also that the gap between them is wider compared to L1 students. In terms of S-S, overall Verbal students showed higher preference than Visual students, and the gap between them is wider compared to L1 students. In terms of strength level analysis, both Visual-moderate and strong levels scored higher than Verbal students for all interactions. In the contrary, Verbal-mild students scored higher than Visual students for all types of interactions (Appendix 8-Figure A4.13).

For ML, it is demonstrated that S-I interaction has the highest score at all levels, followed by S-S, then S-T. However, in terms of S-I, overall Visual students showed higher preference of use of this type of interaction compared to Verbal students. However, it is noticeable also that the gap between them is narrow similar to L1. In terms of S-T, overall Verbal students showed higher preference of use of this type of interaction compared to Visual students. Similarly, in terms of S-S, overall Verbal students showed higher preference than Visual students. In terms of strength level analysis, Visual-strong/moderate scored higher than Verbal students for all interactions. In the contrary, Verbal-mild students scored higher than Visual students for all types of interactions (Appendix 8-Figure A4.14).
L1, S-I interaction has the highest score at all levels in terms of perception of its use, followed by S-S, then S-T. However, in terms of S-I, overall Reflective students showed higher preference of use of this type of interaction compared to Active students. In terms of S-T, overall Active students showed higher preference of use of this type of interaction compared to Reflective students. However, it is noticeable that the gap between them is wider compared with S-I interaction. In terms of S-S, overall Active students showed higher preference than Reflective students, and the gap between them is narrower than the other interactions. In terms of strength level analysis, both Active-moderate and strong levels scored higher than Reflective students for all interactions. In the contrary, Reflective-mild students scored higher than Active-mild students for all types of interactions (Appendix 8-Figure A4.15).

For L2, Active students scored the highest for S-I interaction followed by both S-S and S-T. On the other hand, Reflective students scored higher for S-T interaction followed by both S-S and S-I. In terms of strength level analysis, both Active-strong and mild levels scored higher than Reflective students for all interactions. In the contrary, Reflective-moderate students scored higher than Active-moderate students for all the interactions (Appendix 8-Figure A4.16).

For ML, S-I interaction has the highest score at all levels in terms of frequency of use, followed by S-S, then S-T. However, in terms of S-I, overall Reflective students showed higher preference of use of this type of interaction compared to Active students. However, it is noticeable also that the gap between them is narrow. In terms of S-T, overall Reflective students showed higher preference of use of this type of interaction compared to Active students. However, it is noticeable also that the gap between them is wider than S-I. In terms of S-S, overall Reflective students showed higher preference than Active students, however with a very narrow gap between them. In terms of strength level analysis, Active-strong/moderate scored higher than Reflective students for all interactions. In the contrary, Reflective-mild students scored higher than Active students for all types of interactions (Appendix 8-Figure A4.17).

4.5 Learning preferences

Choice between CMLIs and TLIs

Students where asked to indicate their choice between CMLIs and TLIs (Traditional Learning Interactions) in terms of attending lectures: ‘If I am given a choice between attending a face-to-face lecture (traditional) or alternatively watching it virtually (on the Web), I will choose:’
Overall, all scored higher preference for traditional rather than virtual learning. In comparison between the LSs, Reflective students scored the highest for CMLIs, followed by Visual students, then Active and Verbal students (Figure 4.40).

![Figure 4.40 Choices between CMLIs and TLIs (AR and VV)](image)

The results show that Visual students seem to choose virtual learning more than Verbal students who prefer traditional learning more than virtual (Figure 4.41).

![Figure 4.41 Choices between CMLIs and TLIs](image)

In terms of L1 students, overall Verbal students scored higher than Visual students for traditional lecture, however Visual students scored higher for virtual lecture (Appendix 8-Figure A4.18). Similarly L2 students, Verbal students scored higher than Visual students for traditional; however Visual students scored higher for virtual. In comparison with L1, the gap between the two styles is wider (Appendix 8-Figure A4.19). Similarly, ML students, Verbal students scored higher than Visual students for traditional, however Visual students scored higher for virtual than Verbal students. In comparison with L1 and L2, the gap between the two styles is wider than both (Appendix 8-Figure A4.20).

In comparison between the three levels, it is noticeable that higher percentage of Visual students at all levels are prepared to choose the virtual method than Verbal students, with L1 scored the
highest percentage, followed by L2, the ML. Overall, the gap between the two styles gets wider as the level of study goes up towards ML. However, in terms of the stronger levels of LSs, the gap between the two styles was at its highest at L2, followed by ML, and at its narrowest at L1 (Figure 4.42).

![Figure 4.42 Comparison between the three levels in terms of choosing the virtual method (VV)](image)

In terms of Active/Reflective students, overall, all scored higher preference for traditional rather than virtual learning. Reflective students seem to choose virtual learning more than Active students, who prefer traditional learning more than virtual (Figure 4.43).

![Figure 4.43 Comparison between the learning styles (AR)](image)

Overall L1 Reflective students scored higher than Active students for virtual, however Active students scored higher for traditional lecture (Appendix 8-Figure A4.21). In terms of L2 students however, both Active and Reflective students scored the same for virtual and traditional lecture. In comparison with L1, the gap between the two styles is wider towards traditional learning more than virtual. In terms of the stronger levels of LSs, Reflective students scored higher than Active students for virtual (Appendix 8-Figure A4.22). Similarly, ML students, Reflective students scored higher than Active students for virtual, however Active students scored higher for traditional than Reflective students. In comparison with L1 and L2, the gap between the two styles is wider than both, however it is closer to L1 than L2, which is more balanced (Appendix
8-Figure A4.23). On the other hand, in comparison between the three levels, it is noticeable that higher percentages of Reflective students at all levels are prepared to choose the virtual method than Verbal students, with the exception of L2 which is balanced. L1 scored the highest percentage, followed by ML, then L2. Overall, the gap between the two styles is wider towards ML, and narrower towards L1. In the contrary, in terms of the stronger levels of LSs, the gap between the two styles was at its widest at L2 and narrowest at L1 (Figure 4.44).

![Figure 4.44 Comparison between the three levels in terms of choosing the virtual method (AR)](image)

**Degree of augmentation between CMLIs and TLIs**

Students where further asked to indicate their perception of CMLIs as the sole learning interactions with no TLIs: ‘I would like to see the modules I am studying taught only by web-based learning material with no face-to-face lectures/tutorials’. Overall, most students disagree with this statement (73%) and only 5.8% agree (Figure 4.45).

![Figure 4.45 Overall opinions of CMLIs replacing TLIs](image)

In terms of LSs, higher percentages of Active than Reflective students agree with the statement. In terms of Visual-Verbal LSs, slightly higher percentages of Visual than Verbal students agree with the statement (Appendix 8-Figure A4.24). In comparison, however overall Active students
scored the highest, followed by Visual students, then Verbal, and Reflective students (Figure 4.46).

![Figure 4.46 Comparisons between LSs (AR and VV)](image)

Visual students scored slightly higher in L1 and L2 than Verbal students. However, the opposite occurred at ML (Appendix 8-Figure A4.25). Active students scored higher at all levels than Reflective students; with the wider gap between them at L1, followed by L2, then the narrowest at ML (Appendix 8-Table A4.39).

Students where further asked to indicate their perception of TLIs as the sole learning interactions with no CMLIs: ‘I would like to see the modules I am studying taught only by face-to-face lectures/tutorials with no web-based learning material’. Similar to the previous statement, overall, most students disagreed with this statement (62.4%) and only 10.6% agree (Figure 4.47).

![Figure 4.47 Overall opinions of no CMLIs](image)

In terms of LSs, overall higher percentages of Active than Reflective students agree with the statement. In terms of Visual-Verbal LSs, approx the same percentage of both Visual and Verbal agree with the statement, however, more Verbal students disagree with the statement. In the contrary, Visual-strong students scored far higher than Verbal-strong students in disagreeing with the statement (Appendix 8-Figure A4.26). In comparison, overall Active students scored the
highest, followed by Visual students and Verbal, then Reflective students. Verbal students scored slightly higher in L1 and ML. however, Visual students scored slightly higher in and L2 than Verbal students. Despite that the results here are similar to question 84, slightly more students agree with it than in q84 (Appendix 8-Figure A4.27). On the other hand, Active students scored higher at all level than Reflective students, with the wider gap between them at L1, followed by L2, then the narrowest at ML (Figure 4.48).

Students where further asked to indicate their perception of CMLIs as the main learning interactions, with some face-to-face augmentation: ‘I would like to see the modules I am studying taught mainly through the web and complemented by face-to face lectures/tutorials’. Despite that higher percentage of students disagreed with this statement (40.7%) than agreed (31.7%), the gap between them is far narrower than the previous two statements, and that more students agree with this statement and less disagree compared with the previous two statements (Figure 4.49).

In terms of LSs, overall higher percentages of Reflective than Active students agree with the statement. In terms of Visual-Verbal LSs, overall slightly higher percentages of Visual than Verbal students agree with the statement (Appendix 8-Figure A4.28). In comparison, overall
Reflective students scored the highest, followed by Visual students, then Active and Verbal students (Figure 4.50).

Furthermore, Visual students scored higher than Verbal students at all levels. Visual students scored slightly higher in L1 and L2, however, Visual students scored highest in ML. Visual-strong/mod students scored far higher than Verbal-strong/moderate students with the widest gap between them at L1, followed by L2, while at ML they were approx the same (Appendix 8-Figure A4.29). On the other hand, Reflective students scored higher than Active students at L1 and ML, while they were approx the same at L2. In the contrary, L1 Active-strong/moderate students scored higher than Reflective-strong/mod, while L2 and ML Reflective-strong/mod scored higher than Active-strong/moderate students (Appendix 8-Table A4.40).

Students where further asked to indicate their perception of CMLIs as an augmentation to face-to-face learning interactions: ‘I would like to see the modules I am studying taught mainly by face-to-face lectures/ tutorials and complemented by some web-based learning material’. Overall, most students agreed with this statement (71.4%) and only 6.9% disagree (Figure 4.51).
In terms of LSs, overall higher percentages of Active than Reflective students agree with the statement. In terms of Visual-Verbal LSs, overall higher percentages of Verbal than Visual students agree with the statement. In the contrary, Visual-strong/moderate students scored far higher than Verbal-strong/moderate students (Appendix 8-Figure A4.30).

In comparison, overall Verbal students scored the highest, followed by Active students, then Visual, and Reflective students (Figure 4.52).

Verbal students scored higher than Visual students at all levels, except L1, where Verbal students scored the same as Visual students. In the contrary, Visual-strong/moderate students scored far higher than Verbal-strong/moderate students at all levels, with wider gap at L1 and ML, and narrower at L2 (Appendix 8-Figure A4.31).

Active students scored higher at all levels than Reflective students, with the wider gap between them at L1, followed by L2, then the narrowest at ML. Active-strong/moderate students scored higher than Reflective-strong/moderate students at ML and L1, with the exception of L2, where Reflective-strong/moderate students scored far higher than Active-strong/moderate students (Appendix 8-Table A4.41).

Students where further asked to indicate their perception of CMLIs in relation to TLIs: ‘If I have a problem understanding a topic, I tend to e-mail the lecturer/tutor rather than seeing him/her face to face’. Overall, high percentage of students disagreed with this statement (49.7%) in comparison with the ones who agreed (Figure 4.53).
In terms of LSs, overall slightly higher percentages of Reflective than Active students agree with the statement. In terms of Visual-Verbal LSs, overall slightly higher percentages of Visual than Verbal students agree with the statement (Appendix 8-Figure A4.32).

In comparison, the gap between the styles are very narrow here, however overall Reflective students scored the highest, followed by Visual students, then Verbal and Active students (Figure 4.54).

Visual students scored slightly higher than Verbal students in L1 and L2. However, Verbal students scored higher in ML (Appendix 8-Figure A4.33). Reflective students scored slightly higher than Active students at ML and L1, with the exception of L2, where Active students scored slightly higher than Reflective students. However, L1 Active-strong/moderate students scored higher than Reflective-strong/moderate students, where both ML and L2 Reflective-strong/moderate students scored higher than Active-strong/moderate students (Appendix 8-Table A4.42).
Students were further asked to indicate their perception of using CMLIs rather than TLIs: 'I prefer downloading lecture slides/notes rather than taking notes in lecture'. Overall, most students agreed with this statement (68.3%) and only 9.5% disagree (Figure 4.55).

In terms of LSs, overall higher percentages of Reflective than Active students agree with the statement. In terms of Visual-Verbal LSs, higher percentages of Visual than Verbal students agree with the statement (Appendix 8-Figure A4.34). In comparison, overall Reflective and Visual students scored the highest, followed by Active, then Verbal students (Figure 4.56).

Visual students scored higher for all levels. However, in terms of strength level analysis, Visual-strong/moderate students scored far higher than Verbal-strong/moderate students at L1 and L2, with the exception of ML, where Verbal-strong/moderate students scored higher than Visual-strong/moderate students (Appendix 8-Figure A4.35). Reflective students on the other hand, scored higher at all levels than Active students, with the wider gap between them at ML, followed by L1, then the narrowest at L2 (Appendix 8-Table A4.43).
Students were further asked to indicate their perception of CMLIs in relation to TLIs: 'I prefer learning from books rather than learning from the computer screen'. Overall, higher percentage of students agreed with this statement (41.3%) and 24.9% disagree (Figure 4.57).

In terms of LSs, overall higher percentages of Reflective than Active students agree with the statement. In terms of Visual-Verbal LSs, higher percentages of Verbal than Visual students agree with the statement (Appendix 8-Figure A4.36).

In comparison, overall Verbal students scored the highest, followed by Reflective students, then Active and Visual students (Figure 4.58).

Overall, Verbal students scored higher for all levels than Visual students. However, in terms of strength level analysis, Verbal-strong/moderate students scored higher than Visual-strong/moderate students at L1 and L2, with the exception of ML, where Visual-strong/moderate students scored higher than Verbal-strong/moderate students (Appendix 8-Figure A4.37). Active students on the other hand, scored slightly higher than Reflective students at L1 and ML, with the exception of L2.
4.6 Summary

This chapter presented the results of the main stage of the research (phase one), which will be further, discussed and analysed in chapter 6. This chapter was concerned with diagnosing students' LSs profile and students' attitude towards voluntary based choice of CMLIs in terms of students ‘use’, ‘perception’ and ‘learning preferences’. It included three successive survey questionnaires distributed to three study levels (L1, L2 and ML). Phase one looked at general issues related to CMLIs with no reference to specific contexts, settings or learning environments. The results highlighted several important points regarding LSs some of which are: different LSs do exist amongst computer students with different variations of attitude towards the 3-CMLIs. As indicated throughout this chapter, the overall results showed that Active students have scored highest levels of use in all interactions S-I followed by and S-S and then S-T, and Reflective students scored the lowest of use of all interactions (highest at S-I, followed by S-S, then S-T). In the second place come Visual learners for both S-I and S-T, and Verbal learners for S-S. In the third place come Verbal students for both S-I and S-T, and Visual learners for S-S. In terms of perception of CMLIs usefulness for learning, Visual students scored highest levels in all interactions S-I followed by and S-S and then S-T, and Verbal students scored the lowest of use of all interactions (highest at S-I, followed by S-S, then S-T). In the second place come both Active and Reflective learners. In terms of learning preferences between traditional and CMLIs, all styles have show clear preference to TLIs, however it is also noticeable that all preferred that CMLIs to augment TLIs rather than the other way round. The next chapter (5) presents the secondary stage of the study (phase two) of the research and results, which will seek to look closer at students’ attitude in relation to their LSs, in specific settings involving non-voluntary choice of CMLIs.
Chapter 5- Phase Two Results

5.1 Introduction

Chapter four presented the results of the main stage of the research (phase one), which was concerned with diagnosing students’ LSs profile and students’ attitude towards CMLIs (voluntary choice) in terms of students use, perception and learning preferences. This chapter presents the secondary stage of the study (phase two) of the research and results, which seeks to look closer at students’ attitude in relation to their LSs, in more specific application based settings involving non-voluntary based choice of CMLIs. The first is a computer lab setting, which incorporates a cross-sectional survey, small-scale, and built around the index of LS instrument, and a self-reported questionnaire. This is to look for links between student’s Visual-Verbal LSs and their attitude towards the two different contents presentations (S-I). The second setting is concerned with students’ attitude towards using WebCT learning interactions. It includes a cross-sectional, small-scale survey, built around the index of LS instrument, and a self-reported questionnaire in the presence of the researcher, and observation throughout one semester of the statistics provided by WebCT learning environment in terms of frequency of access.

5.2 Computer lab setting results

5.2.1 Outcome analysis of the index of LSs

Overall, the learners exhibited a very high preference towards Visual (91%) (Figure 5.1).

![Figure 5.1: Percentage of Visual-Verbal LSs](image-url)
69% of learners exhibited 'strong-moderate' visual preference (Figure 5.2).

![Figure 5.2 Breakdown of Visual style](image)

In contrast, learners exhibited a very low preference towards the Verbal LS (9%), out of which only 3% exhibited a 'strong-moderate' verbal preference (Figure 5.3).

![Figure 5.3 Breakdown of Visual style](image)

It was also found that those students enrolled on the MSc Information Systems (IS) degree displayed total preference to visual learning (100%), 80% of which exhibited a 'moderate-strong' preference towards visual learning, and 0% who exhibited a 'moderate-strong' preference towards verbal learning. However, Distributed Systems (DS) students expressed a lower preference for visual learning (80%) than IS students, 53% of which exhibited a 'moderate-strong' preference towards visual learning, while only 7% exhibited a 'moderate-strong' preference towards verbal learning (Appendix 10- Figure A5.1).
5.2.2 Relationship with CMLIs

*Easiness of learning (SQL and QBE)*

Overall, students were asked to indicate their perception of learning SQL (which is dominantly textual presentation) in relation to QBE (which is dominantly graphical presentation), in terms of easiness: 'I found it easier to learn: SQL/QBE'. The overall results show that the majority of students found it easier to learn SQL (66%) than QBE (34%). In terms of LS, overall, both styles demonstrated very close preference towards SQL and QBE, with higher preference towards SQL (Figure 5.4).

![Figure 5.4 Preferences towards SQL and QBE](image-url)

However, there is no statistical significant evidence for an association between VV, and finding SQL/QBE easy ($p > 0.05, \chi^2=0.001$). In terms of strength level analysis, Visual (moderate-strong) students scored higher for SQL (62.5%) than QBE (37.5%). In contrast, Verbal (moderate-strong) students scored higher for QBE (100%) than SQL (0%) (Figure 5.5).

![Figure 5.5 Strength level analysis](image-url)
Furthermore, Visual (mild) students scored higher for SQL (75%) than QBE (25%). In contrast, Verbal (mild) students scored higher for SQL (100%) than QBE (0%) (Appendix 10-Figure A5.2).

**IS**
The overall results show that the majority of students found it easier to learn SQL (70%) than QBE (30%). In terms of LS, overall, dominant Visual students demonstrated higher preference towards SQL rather than QBE (Appendix 10- Figure A5.3). In terms of strength level analysis, dominant Visual (moderate-strong) students scored higher for SQL (68.75%) than QBE (31.25%) (Appendix 10- Figure A5.4). Similarly, Visual (mild) students scored higher for SQL (75%) than QBE (25%), which indicates no major differences here between different strength levels (Appendix 10- Figure A5.5)

**DS**
The overall results show that the majority of students found it easier to learn SQL (60%) than QBE (40%). In terms of LS, overall, both styles demonstrated higher preference towards SQL than QBE. On the other hand, Visual students demonstrated higher preference towards QBE compared with Verbal students. However, Verbal students demonstrated higher preference towards SQL compared with Visual students (Appendix 10- Figure A5.6). However, in terms of strength level analysis, Visual (moderate-strong) students scored equally for SQL and QBE (50%). In contrast, Verbal (moderate-strong) students scored higher for QBE (100%) than SQL (0%) (Appendix 10- Figure A5.7). Furthermore, Visual (mild) students scored higher for SQL (75%) than QBE (25%). In contrast, Verbal (mild) students scored higher for SQL (100%) than QBE (0%) (Appendix 10- Figure A5.8).

**Choice of use**
Students where further asked to indicate their preference between using SQL and QBE in real life situation (rather than classroom): 'If I have a choice between using SQL and QBE in real life, I will choose: SQL/QBE'. The overall results show that the majority of students showed higher preference towards SQL (89%) than QBE (11%). In terms of LS, overall, both styles demonstrated higher preference towards SQL than QBE. Verbal learners unanimously (100%)
chose using SQL rather than QBE. However, there is no statistical significant evidence found for an association between VV and preference of use of SQL/QBE ($p > 0.05, \chi^2 = 0.42$).

In comparison, Visual learners showed a higher preference for using QBE (12.5%) than Verbal students (Figure 5.6).

However, in terms of strength level analysis, Visual (moderate-strong) students scored higher for SQL (87.5%) than QBE (12.5%). In contrast, Verbal (moderate-strong) students scored higher for SQL (100%) than QBE (0%) (Figure 5.7).

Similarly, Visual (mild) students scored higher for SQL (75%) than QBE (25%). In contrast, Verbal (mild) students scored higher for SQL (100%) than QBE (0%) (Appendix 10-Figure A5.9).

IS

The overall results show that the majority of IS students chose SQL (90%) than QBE (10%). In terms of LS, overall, the dominant Visual style demonstrated higher preference towards SQL than
QBE (Appendix 10- Figure A5.10). However, in terms of strength level analysis, Visual (moderate-strong) students scored higher for SQL (87.5%) than QBE (12.5%) (Appendix 10- Figure A5.11). However, Visual (mild) students scored higher for SQL (100%) than QBE (0%), which is higher score than Visual (m-s) (Appendix 10- Figure A5.12).

**DS**

The overall results show that the majority of students found it easier to learn SQL (87%) than QBE (13%). In terms of LS, overall, both styles demonstrated higher preference towards SQL than QBE. However, Verbal students demonstrated higher preference than Visual students towards SQL, and Visual students demonstrated higher preference than Verbal students towards QBE (Appendix 10- Figure A5.13). In terms of strength level analysis, similarly both styles score higher for SQL than QBE. Visual (moderate-strong) students scored for SQL (87.5%) than QBE (1.5%). However, Verbal (moderate-strong) students scored higher for SQL (100%) than QBE (0%) (Appendix 10- Figure A5.14). Furthermore, Visual (mild) students scored higher for SQL (75%) than QBE (25%), which is a relatively lower score than Visual (moderate-strong) in terms of SQL, and higher score in terms of QBE. Verbal (mild) students scored higher for SQL (100%) than QBE (0%) (Appendix 10- Figure A5.15).

**Difficulty of learning**

Students were further asked to indicate their perception of SQL and QBE in terms of difficulty to learn: 'SQL or QBE is difficult to learn'. Overall, more students indicated that QBE is more difficult to learn (26%) than SQL (14%). 46% indicated that none of them are difficult to learn, and 14% indicated that both are difficult to learn. In terms of LSs, higher percentage of Verbal students indicated that none are difficult (66.67%) compared with Visual students (43.75%), and higher percentage of Visual students indicated that both are difficult (15.63%) compared with Verbal students (0%). In contrast, higher percentage of Verbal students indicated that SQL is difficult (33.33%) compared with Visual students (12.50%), and higher percentage of Visual students indicated that QBE is difficult (28.13%) compared with Verbal students (0.00%) (Appendix 10- Figure A5.16). However, in terms of strength level analysis, more Visual (moderate-strong) students indicated difficulty of QBE compared to SQL. However, quite the contrary, much more of Verbal (moderate-strong) students scored higher for SQL (100%) than QBE (0%) (Appendix 10- Figure A5.17). However, in terms of Visual (mild) students, higher percentage of them indicated that QBE is difficult compared with Visual (moderate-strong). In
the contrary, all Verbal (mild) students indicated that none of SQL or QBE is difficult to learn (Appendix 10- Figure A5.18).

**IS**

Overall, more students indicated that QBE is difficult to learn (20%) than SQL (10%). 50% indicated that none of them are difficult to learn, and 20% indicated that both are difficult to learn. Similarly, in terms of LSs, more of the dominant Visual students indicated that QBE is difficult than SQL (Appendix 10- Figure A5.19). However, in terms of strength level analysis, more Visual (moderate-strong) students indicated difficulty of QBE compared to SQL, and 50% indicated that none are difficult to learn, while 25% indicated that both are difficult (Appendix 10- Figure A5.20). However, in terms of the mild level, equal percentage of Visual (mild) students indicated that SQL and QBE are difficult, which is higher than Visual (moderate-strong) students (Appendix 10- Figure A5.21).

**DS**

Overall, more students indicated that QBE is difficult to learn (33%) than SQL (20%). 40% indicated that none of them are difficult to learn, and 7% indicated that both are difficult to learn. In terms of LSs, higher percentage of Verbal students indicated that none are difficult (66.67%) compared with Visual students (33.33%), and higher percentage of Visual students indicated that both are difficult (8.33%) compared with Verbal students (0%). In contrast, higher percentage of Verbal students indicated that SQL is difficult (33.33%) compared with Visual students (16.67%), and higher percentage of Visual students indicated that QBE is difficult (41.67%) compared with Verbal students (0.00%) (Appendix 10- Figure A5.22). However, in terms of strength level analysis, equal percentage of Visual (mild) students indicated that SQL and QBE are difficult. However, quite the contrary, much more of Verbal (moderate-strong) students scored higher for SQL (100%) than QBE (0%) (Appendix 10- Figure A5.23). However, in terms of Visual (mild) students, higher percentage of them indicated that QBE is difficult (75%) compared with SQL (0%), which is far higher than Visual (moderate-strong). In the contrary, all Verbal (mild) students indicated that none of SQL or QBE are difficult to learn (Appendix 10- Figure A5.24).

5.2.3 Other noticeable results

The results also show (Appendix 10- Figure A5.25) an indication that students who have a low level of knowledge of SQL prior to starting the module may tend to have higher preference for
visual learning (93%) and a low preference for verbal learning (7%) compared to students who have a higher level knowledge of SQL. 90% of such students show a preference for visual learning in contrast to 10% for verbal learning. Similarly, students who have a low level of knowledge of QBE prior to starting the module tended to have a higher preference for visual rather than verbal learning (95%) than students who have a high level knowledge of QBE, 85% of whom show a preference towards visual learning and only 15% a preference towards verbal learning (Figure 5.8).

These results were reinforced through the finding that students who had a low level knowledge of general computing prior starting the module had a very high preference for visual learning (100%) compared to students who have a high level knowledge of general computing, 100% of whom exhibited a 'moderate-strong' preference towards visual learning. However, students who had a high level knowledge of general computing tended to have a lower preference for visual learning (91%) compared to students who had a low level knowledge of general computing (Figure 5.9), 66% of whom exhibited a 'moderate-strong' preference towards visual learning, while only 34% exhibited a 'moderate-strong' preference towards verbal learning (Figure 5.10). However, there is no statistical significant evidence found for an association between SQL background, and preference of use of SQL/QBE ($p > 0.05, \chi^2 = 2.30$) or between QBE background, and preference of use of SQL/QBE ($p > 0.05, \chi^2 = 0.28$).
Chapter 5: Phase Two Results

5.3 WebCT Learning Environment Results

5.3.1 Outcome analysis of the Index of LSs

The results at the beginning of the semester show that 67% of students are Active (11% are Active-strong and & 56% Active-mild) and 33% are Reflective (33% Reflective-mild) (Figure 5.11)
While the results at the end of semester show that 50% of students are Active students and 50% are Reflective students, none of the students scored strong preference towards any of the styles (Figure 5.12)

![Figure 5.12 AR LSs profile](image)

**5.3.2 Access to WebCT learning environment (Observation)**

The overall results show that Reflective students scored higher overall mean access (Figure 5.13) to WebCT learning environment (166.33 times) during the semester compared to Active students (121.83 times). The results also show that 33.33% of Reflective students have higher accesses (over 200 times) compared with 0% of Active students (Appendix 10- Figure A5.26).

![Figure 5.13 Accesses to WebCT](image)

In terms of strength level analysis, 50% of Reflective-moderate students had higher accesses (over 200) than Reflective-mild, Active-mild and Active-moderate. However, at the low side of the scale (50-150), Active-moderate scored highest, followed by Active-mild, Reflective-mild, and then Reflective-moderate (Figure 5.14). However, there is no statistical significant evidence
for the association between the AR LSs, and times of access to the WebCT learning environment ($p > 0.05$, $X^2=0.44$).

![Figure 5.14 Access to WebCT (strength levels)](image)

**S-I**

The overall results show (Figure 5.15) that Reflective students scored higher mean access to contents pages (89.33 times) during the semester compared to Active students (49.33 times). It also shows that 33.33% of Reflective students have accesses over 150 times compared with 0% of Active students (Appendix 10- Figure A5.27).

![Figure 5.15 S-I Interaction](image)

However, there is no statistical significant evidence for the association between the AR LSs, and number of times accessing the contents pages ($p > 0.05$, $X^2=3.08$).

In terms of strength level analysis, 50% of Reflective-moderate students had higher accesses (over 150) than Reflective-mild, Active-mild and Active-moderate. However, at the lower end of...
the scale (0-100), the results show higher accesses by Active-mild, Active-moderate and Reflective-mild, and then Reflective-moderate (Appendix 10- Figure A5.28).

**S-S**

The results show (Figure 5.16) that Reflective students score higher mean number of postings to the discussion board (4.17 times) compared with Active students (2.67 times).

![Figure 5.16 S-S interaction](image)

Despite that the results show that the majority of Active students (83.33%) posted messages (0-3), 33.33% of Reflective students posted over 4 messages compared with 16.67% Active, and 16.67% of Reflective students have posted more than 8 times compared with 0% of Active students (Appendix 10- Figure A5.29). However, there is no statistical significant evidence for the association between the AR LSs, and number of postings to the discussion board ($p >0.05$, $\chi^2=1.5$).

In terms of strength level analysis, 100% of Reflective-moderate students had higher accesses (4-over) than Reflective-mild, Active-moderate, and Active-mild. However, at the lower end of the scale (0-3), the results show higher accesses by Active-mild, Reflective-mild, Active-moderate and then Reflective-moderate (Appendix 10- Figure A5.30). Despite that, the results showed that Reflective students scored slightly higher mean number of articles read on the discussion board (72.83 times) compared to Active students (69.83 times), and 83.33% of Active students have read more than 100 articles compared with 66.67% of Reflective students (Appendix 10- Figure 5.31). In terms of strength level analysis, 100% of Reflective-moderate and Active-mild students had higher accesses (over 60) than Reflective-mild, and Active-mild. However, at the lower end
of the scale (30-60), the results show higher accesses by Active-moderate than Reflective-mild (Appendix 10- Figure A5.32).

**S-T**

Despite that the results showed that Reflective students scored slightly higher mean number of e-mails to tutor (1.83 times) compared to Active students (1.50 times).

Both Reflective and Active students showed the same percentage of over 4 e-mails to tutor (16.67%) (Appendix 10- Figure A5.33). However, there is no statistical significant evidence for the association between the AR LSs, and number of e-mails to tutor ($p > 0.05, \chi^2=0.00$).

In terms of strength level analysis, 50% of Reflective-moderate and Active-moderate students had higher accesses (4-7) than Reflective-mild, and Active-mild. However, at the lower end of the scale (0-3), the results show higher accesses by Active-mild, Reflective-mild, and then Active-moderate and Reflective-moderate (Appendix 10- Figure A5.34).

**5.3.3 Comparison between the styles**

Overall, students scored higher access to S-I than all other interactions, followed by S-S, then S-T. The result is similar to previous results in phase one. However, Reflective students scored higher than Active students for S-I interaction, and also for S-S interaction. Active students scored equally for S-T (Figure 5.18).
In terms of strength level analysis, Reflective-moderate scored the highest for S-I, followed by Reflective-mild, and then Active-mild. In terms of S-T interaction, both moderate part of the scale for both Active and Reflective students scored higher than the rest of the styles. In terms of S-S interaction, Reflective-moderate scored the highest, followed by Active-moderate, and then Reflective-mild (Appendix 10- Figure A5.35).

5.3.4 Reply to Discussion Board activities (Observation)
Overall Reflective students scored slightly higher percentage in terms of responses to weekly activities compared with Active students. For example, 33.34% of Reflective students responded to over 40% of activities posted to the discussion board compared with 16.67% of Active students. In terms of strength level analysis, Reflective-mild students scored higher response compared with Active-mild students; however moderate students scored equally for both styles (Appendix 10- Figure A5.36).

5.4 Relationship with CMLIs (Questionnaire)
Students were asked to indicate which type of interaction (S-T, S-S, and S-I) is most liked by students in terms of using the web for learning: 'In terms of preference, the thing I like most about using the web for learning is:' The results show that 83.33% of Reflective students selected S-I, while 16.67% selected S-T, and 0% selected S-S. In contrast, 100% of Active students selected S-I, 0% selected S-T, and 0% selected S-S (Figure 5.19).
Chapter 5: Phase Two Results

In terms of strength level analysis, 100% of Reflective-mild, Active-mild and Active-moderate students had chosen S-I interaction rather than other interactions, while 50% Reflective-moderate students chosen S-I and 50% chosen S-T, and 0% S-S (Appendix 10- Figure A5.37).

5.4.1 S-S interaction

Use

When students were asked to indicate their frequency of accessing the web for S-S interaction: ‘I use e-mail to discuss with my peers issues related to the course/ or group work:’, all Reflective students (100%) scored low frequency of 0-1 times/week compared with Active students, who scored higher frequency of use of more than 5 times/week (16.67%) and higher frequency of 2-5 times/week (33.33%) (Figure 5.20). However, there is no statistical significant evidence found for the association between the AR LSs S-S ($p > 0.05, \chi^2 = 1.09$).
In terms of strength level analysis, 25% of Active-mild students had higher accesses (more than 5 times/week) than all others. However, at the middle scale (2-5 times/week) 50% of Active-mild scored higher accesses than all others. However, at the lower end of the scale (0-1/wk), the results show higher percentages by Active-moderate, Reflective-moderate, Reflective-mild, and then Active-mild (Figure 5.21).

**Perception**

Students were further asked to indicate their perception of the following statement concerning the usefulness of the web in terms of S-S interactions: ‘The web is useful for my learning because it makes it easier to communicate with my peers’. The results show that 83.33% of both Active and Reflective students agreed with the statement, and 16.67% neither agreed nor disagreed. In terms of strength level analysis, 100% of Active-moderate and Reflective-moderate agree, followed by Active-mild and Reflective-mild (75%). 25% of Active-mild and Reflective-mild neither agree nor disagree.

**5.4.2 S-I interaction**

**Use**

When students were asked to indicate their frequency of accessing the web for S-I interaction: ‘I use the web to read & download course material/or to search websites for information relevant to my course:’ The results show that, Reflective students scored higher frequency (50%) of more than five times/week compared with Active students (16.67%), while 83.33% of Active students scored higher in the medium frequency between 2-5 times/week compared with
Reflective students (33.33%) (Figure 5.22). However, there is no statistical significant evidence found for the association between the AR LSs and S-I ($p >0.05, \chi^2=3.28$).

![Figure 5.22 Comparison between the LSs](image)

In terms of strength level analysis, 100% of Reflective-moderate students had higher accesses (more than 5 times/wk), followed by Active-mild and Reflective-mild. However, at the middle scale (2-5 times/wk) 100% of Active-moderate scored higher access, followed by Active-mild, then Reflective-mild. However, at the lower end of the scale (0-1/wk), the results show higher percentage by Reflective-mild than all others (Appendix 10- Figure A5.38).

**Perception**

Students where further asked to indicate their perception of the following statement concerning the usefulness of the web in terms of S-I interactions: 'The web is useful for my learning because it makes it easier to search for information and read/download course related material'. The results show that 100% of both Active and Reflective students agreed with the statement. In terms of strength level analysis, 100% of all levels agree with the statement.

### 5.4.3 S-T interaction

**Use**

When students where asked to indicate their frequency of accessing the web for S-T interaction: 'I use e-mail to communicate with my tutors/lecturers:' the results show that both Active and Reflective students had similar scores (33.33%) of more than 2 times/week (Figure 5.23). However, there is no statistical significant evidence found for the association between the AR LSs S-T ($p >0.05, \chi^2=1.09$).
In terms of strength level analysis, 25% of Active-mild students had higher accesses (more than 5 times/wk) than all others. However, at the middle scale (2-5 times/wk) 50% of Active-moderate and Reflective-moderate scored higher accesses, followed Reflective-mild, and then Active-mild. However, at the lower end of the scale (0-1/wk), the results show higher percentage by Active-mild than all others (Appendix 10- Figure A5.39).

**Perception**

Students where further asked to indicate their perception of the following statement concerning the usefulness of the web in terms of S-T interactions: *The web is useful for my learning because it makes it easier to communicate with my tutors/lecturers*. The results show that 100% of both Active and Reflective students agreed with the statement. In terms of strength level analysis, 100% of all levels agree with the statement.

**5.4.4 Comparison between the three interactions**

**Use**

Overall, students scored higher access to S-I than all other interactions, followed by S-S and S-T. Reflective students scored higher than Active students for S-I interaction; however Active students scored higher than Reflective students for S-S, and S-T (Figure 5.24).
Chapter 5: Phase Two Results

In terms of strength level analysis, Reflective-moderate scored the highest for S-I, followed by Reflective-mild, and Active-mild. In terms of S-T and S-S interactions, Active-mild scored the highest access for both interactions (Figure 5.25).

**Perception**

Overall, both styles scored equally very high in their perception of the importance of S-I and S-T followed by S-S. In terms of strength level analysis, all levels scored equally very high in their perception of S-I and S-T, with the exception of S-S where both the moderate part of the scale scored higher than the mild part for both styles.

**5.4.5 Comparison between CMLIs and traditional learning**

**S-I**

Students where further asked to indicate their preference between CMLIs and TLIs: *'If I have the choice between learning from a book or through a computer I will choose:*' the results show that Reflective students scored a balanced preference towards both traditional and computer based
learning. However, Active students scored higher towards computer-based interaction (66.67%) compared with Reflective students (50%) (Figure 5.26).

![Figure 5.26 Contrast between the two styles](image)

In terms of strength level analysis, 100% of Active-moderate students had higher preference towards CMLIs than TLIs, followed by all others (Appendix 10- Figure A5.40).

Students were further asked to indicate their preference between CMLIs and TLIs: ‘If I have the choice between going to library and searching the web for information I will choose:’ both Reflective and Active students showed total preference (100%) preference to CMI. In terms of strength level analysis, 100% of all strength levels chosen CMLIs rather than TLIs.

S-T

Students were further asked to indicate their preference between CMLIs and TLIs: ‘If I have the choice between communicating with my tutor/lecturer by e-mail or face-to-face I will choose:’ The results were close, however Reflective students showed higher (33.33%) preference to CMI compared with Active students (16.67%) (Figure 5.27).

![Figure 5.27 Contrast between the two styles](image)
In terms of strength level analysis, 50% of Reflective-mild students had higher preference towards CMLIs than TLIs, followed by Active-mild and then Reflective-moderate and Active-moderate. Both Active-moderate and Reflective-moderate scored high for TLIs (Appendix 10-Figure A5.41).

**S-T & S-I**

Students were further asked to indicate their preference between CMLIs and TLIs: 'If I have the choice between attending a lecture face-to-face or watching it as Virtual Lecture on the web/online I will choose:' the results show that Reflective students showed higher (33.33%) preference to CMI compared with Active students (0.00%) (Figure 5.28).

![Figure 5.28 Contrast between the two styles](image)

In terms of strength level analysis, 50% of Reflective-moderate students had higher preference towards CMLIs than TLIs, followed by Reflective-mild and then Active-mild and Active-moderate, who scored high for TLIs (Appendix 10-Figure A5.42).

**S-S**

Students were further asked to indicate their preference between CMLIs and TLIs: 'If I have the choice between communicating with my peers by e-mail or face-to-face I will choose:' The results were very close, however all Reflective students (100%) were in favor of face-to-face interaction compared with 83.33% of Active students (Figure 5.29).
In terms of strength level analysis, 25% of Active-mild students had higher preference towards CMLIs than TLIs, followed by all others. Active-moderate, Reflective-moderate, and Reflective-mild scored high for TLIs (Appendix 10- Figure A5.43).

**Comparison**

In terms of comparison between the styles, Active students scored higher for both S-I and S-S compared with Reflective students, while Reflective students scored higher for S-T (Figure 5.30).

In terms of strength level analysis, Active-moderate scored higher for S-I than all other levels, while Reflective-mild scored higher than all other levels for S-T followed by Active-mild. Active-mild scored the highest for S-S than other levels (Figure 5.31).
Other Results

In terms of computer background (Web), both Active students and Reflective students reported high score between Good and Excellent. However, Active students reported higher level (83.33%) compared with Reflective students (33.33%) (Appendix 10- Figure A5.44). In terms of strength level analysis, 100% of Reflective-moderate and Active-moderate students have high Web background (excellent), followed by Active-mild. On the other hand 100% of Reflective-mild students have good level background followed by 25% of Active-mild (Appendix 10- Figure A5.45).

5.5 Summary

This chapter presented the secondary stage of the study (phase two) of the research and results, which is concerned with examining students' attitude in two specific application based settings involving non-voluntary based choice of CMLIs. The first is a computer lab setting, which incorporates a cross-sectional survey, small-scale, and built around the index of LS instrument, and a self-reported questionnaire. It looked for links between student's Visual-Verbal LSs and their attitude towards the two different contents presentations (S-I). The second setting was concerned with students' attitude towards using WebCT learning interactions and included a cross-sectional, small-scale survey, built around the index of LS instrument, and a self-reported questionnaire in the presence of the researcher, and observation of the statistics provided by WebCT learning environment. The findings of the first setting demonstrated that LSs seems to have some link with students' preferences towards using different presentations. Despite that, the majority of students of both styles found it easier to learn SQL, of which they possess a higher level of existing knowledge than QBE. It also highlighted some differences in students' attitude.
towards the 3-CMLIs compared to phase one, particularly in terms of the nature of the learning environment. The next chapter (6) analyses and discusses the results reported in this chapter and previous chapter. It looks at phase one and two results in terms of students’ LSs profile and strength level of each style, attitude towards the 3 different types of CMLIs and comparison between them. It discusses the findings in terms of the association between LSs and students’ use of the 3 types of CMLIs, common attitudes towards the 3-CMLIs, students’ preferences towards using and learning different contents presentations (S-I), and students’ degree of access to WebCT learning environment (S-S and S-T interactions). It concludes with the possible implications of the findings on the ILS design.
Chapter 6- Discussion and Reflection on the Results

6.1 Introduction

Chapters four and five presented the main and secondary phases (one and two) of the research and results, which will be further, discussed and analysed in this chapter. Chapter four was concerned with diagnosing students' LSs profile and students' attitude towards voluntary based choice of CMLIs in terms of students use, perception and learning preferences. It included three successive survey questionnaires, built around the Index of Learning Styles Instrument, and a self-reported questionnaire, distributed to three study levels including undergraduate and postgraduate levels (L1, L2, and ML). Chapter five presented the results of the second phase, which constituted two different settings. The first was a lab setting which incorporated a cross-sectional survey, small-scale, built around the Index of Learning Styles Instrument, and a self-reported questionnaire, and also incorporated observation of WebCT statistical records of students' access to the learning environment. The first setting was to look more specifically for links between student's VV LSs and their attitude towards S-I in terms of the two different presentations (SQL/QBE). The second setting was concerned with students' attitude towards using WebCT learning interactions, with a particular focus on S-T and S-S interactions. This chapter discusses and reflects on the results presented in the previous two chapters in relation to the aims and objectives (chapter one), and questions raised (chapter two). It summarises the meaningful results in terms of relationships, relative theory, and other factors that could have influence on them, and tries to put forward a meaningful interpretation of the findings. The following sections are arranged in the same order of the research objectives described in chapter one.

6.2 Exploring the students' LSs profile

From LSs perspective, the results highlight the importance of active learning processes and visual presentations in terms of proportion of LSs exhibited by computer students. Table 6.1 summarises some of the findings, which is discussed in this section. It was shown that Visual students occupy very high proportion compared with all the other styles, with Active students second, followed by
Chapter 6: Discussion and Reflection on the Results

reflective and then Verbal students (section 4.2). Furthermore, a higher proportion of Visual students showed preference to the Active LS rather than the Reflective. On the other hand, the overall results for all three groups (L1, L2 & ML) showed no significant differences between them in terms of the order of styles and their proportion of styles (that is, Visual, Active, then Reflective and Verbal) which may give an indication of the preferred LSs that computer students may have in common. The above findings support and confirm the literature in chapter two, but from a different perspective, that is, LSs perspective. For example Mayer (2001) in terms of the importance of visual presentation or 'picture' (static or dynamic) and its augmentation with 'word' (spoken and written) in the multimedia design, and active learning (For example Brookes, 1997; Bonk, 1999; Park, 2003), and importance of the strategy applied to the design (Rice et al, 1999). It also re-enforced, from LSs perspective, the importance of allowing for reflection (Laurillard, 2002) in the design for Reflective LSs and the purposeful use of written and spoken word (Mayer, 2001) for Verbal LSs, in a balanced way with other styles.

There is also an indication, however small, that may suggest change of style as level of study change. For example, it is noticeable that the tendency towards the Visual style gets less the higher the level becomes, and vice versa, the Verbal style increases as the level goes up. This may support Mayer’s (2001) findings that the need for visual presentation become less important as the level of prior subject knowledge increases, and Rieber’s (1996) that the type of representation that is best for learning shifts over time. Similarly, but to a lesser degree, the tendency towards the Active style gets slightly less the higher the level becomes, which was noticeable between L1 and L2, however ML was closer to L1 rather than L2. On the other hand, the Reflective style increases slightly as the level goes up, which was noticeable between L1 and L2, however ML was closer to L1 rather than L2.

In terms of strength level analysis, the proportion of students with strong LSs in relation to mild styles is wider in L1 and ML and milder or more balanced in L2. The similarity between L1 and ML is despite of the differences in population composition of L1 and ML in terms of age, first language, gender, and general computer experience; however they both reported similar high internet/web background. This may be interpreted that both L1 and ML where at early stage of their course (1st semester-when the data was collected) compared with L2 (3rd semester- when the data was collected), which may indicate that as the students progress through the course their strong LSs tendencies become milder or more balanced. Such similarity between L1 and ML may also be due similarities in prior knowledge of the internet/web.
Chapter 6: Discussion and Reflection on the Results

Key findings and relevant theory from literature

<table>
<thead>
<tr>
<th>Students show higher preference towards Active &amp; Visual styles</th>
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<tbody>
<tr>
<td>Highlights and strengthens the need for active learning processes and visual presentations for computer students- supports and confirm some of literature in chapter two, but from a different perspective, i.e. LSs perspective. For example Mayer (2001) in terms of the importance of visual presentation and augmentation aspect between word (spoken and written) and picture (static or dynamic) in the multimedia design, and active learning (For example Brookes, 1997; Bonk, 1999; Park, 2003), and importance of the strategy applied to the design (Rice et al, 1999). It also re-enforce, from LSs perspective, the importance of allowing for reflection (Laurillard, 2002) in the design for Reflective LSs and the use of written and spoken word (Mayer, 2001) for Verbal LSs, in a balanced way with other styles.</td>
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<table>
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<tr>
<th>Students show high proportion of strong/moderate LSs</th>
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<tr>
<td>This is a new finding in relation to computer students. Strong/moderate AR LSs formed nearly 40% of the populations of the 3 groups, while the VV LSs formed between 50-70% which is not small portion of the population that requires attention in the design.</td>
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<table>
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<tr>
<th>Students from different groups show differences in proportion of LSs and strength levels</th>
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<tr>
<td>There are some similarities as well as some differences. Possible indicator of change of learning strategies over time and/or as knowledge increases – this was noticeable in the comparison between both L1 and ML (who are at the beginning of their course) in comparison with L2 (who are in the middle of their course). This supports Rieber (1996) and Mayer’s (2001), but from a different view to them, i.e. the LS view.</td>
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<tr>
<th>Visual students show tendency to the Active LS</th>
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<tr>
<td>This is a new finding in terms of the relationship between the two styles for computer students which suggests the importance of incorporating combined elements of activities and visual presentations for achieving a more interactive design.</td>
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Table 6.1 Exploring students' LSs profile

6.3 Exploring common attitudes towards the 3-CMLIs

This study explored the relationship between students' LSs and their attitudes towards the 3-CMLIs through finding out (research question-chapter 1) whether students with different/similar LSs had different/similar attitudes towards using and perceiving CMLIs. It sought to test the validity of the hypotheses that, student’s LS might be associated with student’s attitude towards the use of 3-CMLIs, perception, and learning preferences. In other words, it hypothesised that some students with particular LSs are more prepared to use CMLIs than others. Consequently, it sought to find out whether LSs can be used as predictors of students’ preference and perception of different types of CMLIs as a prerequisite for developing adaptive and adaptable ILSs. Therefore, contextual variables such as performance or learning outcome were not explored in this research as previously discussed (chapter 1, section 2.2.4), and as it did not intend to investigate the effect of students’ attitude on their performance, but rather, focused on students’ differences in relation to their attitudes towards CMLIs that constitute essential part of ILSs (see chapter 2). Further, learning is difficult to measure, and can be a resultant of many factors and attributes (that are out of the scope of this research), whether directly or indirectly, some of which are accommodating...
students' learning preferences (focus of this research), and that through looking at students' learning preferences we can understand and find out more about students' attitudes and why they do what they do to inform the interactivity design, which consequently can have positive effects on students' learning experience including learning outcome (Ramsden, 1988; Garrison, 1990; Entwistle and Entwistle, 1991; Hackman and Walker, 1990; Ritchie and Newbury, 1989; Schell and Branch, 1993; Wagner, 1994). Table 6.2 summarises some of the key findings, which are discussed in this section. In terms of the relationship between LSs and CMLIs (voluntary choice), the results showed that all LSs scored highest level of use towards S-I interaction, followed by S-S then S-T.

### Key findings & relation to literature reviewed

<table>
<thead>
<tr>
<th>Students show differences between the LSs use of CMLIs</th>
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<tr>
<td>Show common attitudes, Active students use all three interactions more than Reflective learners in the voluntary choice context. This was also clearer and more noticeable for the (Strong/moderate side of the scale). This supports Felder's (1993) learning style model in terms of the information processing for Active learners. Moreover, the study found statistically significant evidence for an association between AR strong end of the scale, and high/low use of S-I and S-S that the proportion of Active LS with high use differs significantly from the proportion of Reflective with high use (see chapter 4). However, it found no statistically significant evidence for an association between AR strong end of the scale, and high/low use of S-T, which may be due to the low use of S-T interaction.</td>
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<tr>
<th>Match between students Use and perceptions of usefulness of the 3-CMLIs</th>
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<tr>
<td>This supports Davis (1989) TAM model in relation to the influential factors on students' attitude towards the use of technology such as 'perceived usefulness'. It also confirms and supports Collis's 4-E model (Collis et al, 2000), Goodhue (1995), (Welke and Konsynski, 1980), Keller's (ARCS) model (Keller, 1983), and Campbell and Campbell (1999).</td>
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<th>Students show differences between the groups</th>
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<td>There are some consistencies as well as inconsistencies in the use of different interactions. This is a new finding in terms of computer students and the 3-CMLIs; however it requires further investigation of other individual differences.</td>
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<table>
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<tr>
<th>Reflective students show different use of Interactions between VDLE and TDLE</th>
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<tr>
<td>For the non-voluntary context, Reflective students used S-S more frequently than Active students. This may suggest that CML tools may alter the Reflective students' attitude towards S-S described by Felder (1993) compared with Active students, through its asynchronous nature. Also, it was found that Reflective students showed higher preference to CMLIs than TLIs compared with Active students. This is a new finding; however it needs more investigation due to the small size of this population used.</td>
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<th>Students preference of the degree of augmentation between CML and traditional methods</th>
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<tr>
<td>Explored that students still generally appreciate TLI more than CML. However, they indicated their appreciation of CML through complementing TLI rather than vice versa. This opinion seems to support two of the three models of Mason's (1998b) described in CH2 in terms of the degree of augmentation of CMLIs, the Content+ Support Model and the Wrap-Around Model rather than the Integrated Model.</td>
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<th>Students' prior knowledge dominance over LSs</th>
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<tr>
<td>Some indication of an influential role for prior knowledge over LSs has been noticed to dominate students' preference of use (Chapter 5) between the use of textual and visual presentations. This is a new finding which require further research to find out the relationship between them and possible influential role of prior knowledge on LSs</td>
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<th>Students of mild LSs show Inconsistency in their use of the Interactions</th>
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<tbody>
<tr>
<td>Also some indications of inconsistency of mild LSs' use of CMLIs. This supports Felder (1993) in terms that the mild learner will have no learning difficulties to go towards each side of the dimension.</td>
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Table 6.2 Exploring common attitudes towards the 3-CMLIs

Interactive Learning Systems for HE

K. A. Sabry
It also shows that, the gaps between the LSs in terms of using S-I interaction are narrower in general compared with the other interactions, which may indicate the degree of importance of such type of interaction to all students. The results also show some common attitudes between LSs and the 3-CMLIs (voluntary choice), which are indicated as follows:

6.3.1 Phase one

*Use of the 3-CMLIs*

- Active students use all three interactions more than reflective learners. Visual students use S-I and S-T more than Verbal students, but they are close in terms of S-S; however, Verbal students are slightly higher.

- The study found statistically significant evidence for an association between AR strong end of the scale, and high/low use of S-I and that the proportion of Active LS with high use differs significantly from the proportion of Reflective with high use (see chapter 4). It also found statistical evidence that, relationship exists between AR strong end of the scale, and high/low use of S-S, and that the proportion of Active LS with high use differs significantly from the proportion of Reflective with high use. However, it found no statistical significant evidence for an association between AR strong end of the scale, and high/low use of S-T, which may be due to the lower use of S-T interaction as discussed above.

- In terms of the effects of LSs strength levels, For S-S interaction, the Visual style (moderate-strong) scored higher use than Verbal (moderate-strong), while Verbal (mild) scored higher than Visual (mild) students. In terms of S-I interaction, both Visual and Active students (moderate-strong) scored closely the highest, followed by Verbal then Reflective students. However, in terms of S-T interaction, Active and Visual students (moderate-strong) scored closely the highest use, followed by Reflective then Verbal students.

- There were some variations between LSs at different Levels of study, For S-I Active learners scored higher use for both L2 and ML, while L1 Reflective scored closely to Active, but with slightly higher percentage. Visual scored higher use than Verbal at all levels. For S-T Active learners scored higher use for both L1 and L2, while ML Reflective scored higher than Active. Similarly Visual scored higher use for both L1 and L2, while ML verbal scored higher than visual. For S-S Active scored higher use at all
levels compared with reflective. However, the result shows generally an increase of frequent-regular use as level goes up for all styles, which may be due to increase in familiarity and knowledge of using the technology. Visual scored higher use for L1, while L2 and ML Verbal scored higher than Visual. Such finding indicate the need to take into account in the interactive design other factors that might influence the LS or strategy the learner take in different situations.

Perception of the 3-CMLIs

- In terms of students perception of the usefulness of CMLIs for learning, similar to the use results, it is clear from the results that all LSs scored closely high for their perception towards S-I interaction, followed by S-S, then S-T. The consistency of this order is a new finding in terms of computer students and the 3-CMLIs and suggests and identifies the degree of importance of each type of interaction from a user view (student). Furthermore, the match between perception of usefulness and the order of actual use may indicate that students' use of these interactions is affected by their perception of its usefulness. This supports Davis (1989) TAM model in relation to the influential factors on students' attitude towards the use of technology such as 'perceived usefulness'. It also confirms Collis's 4-E model (Collis et al, 2000), which argued that individual's likelihood of using WBL for learning 'assuming a voluntary choice is involved' can be expressed in terms of four groups of factors, one of which is the perceived Educational Effectiveness. It also, supports Goodhue (1995), that actual use of computer systems may also be influenced by factors such as matching user needs in achieving a particular task, and whether the use of the systems is based on voluntary or non voluntary use (Welke and Konsynski, 1980). It also, supports Keller's (ARCS) model in that a person's motivation can be increased if it the task is relevant to the person and gives the person satisfaction (Keller, 1983). Also, it may support Campbell and Campbell (1999) that student's motivation increases when learners are able to use their particular LS.

One thing is very noticeable however, is that Visual students scored higher than Verbal students particularly for S-I, followed by S-S, then S-T. However for the A-R dimension, they were close for all three types of interaction. For S-I, generally L1 and L2 scored a high score for all styles. For L2 however, Active and Visual learners scored very high while Verbal students scored medium and Reflective scored high. Reflective students
scored higher than Active students at L1 and ML, but lower at L2. On the other hand, Visual learners scored higher than Verbal students at all levels. For S-T, L1 Active students scored high while Reflective scored mid, L2 was balanced, while ML Reflective scored high and active scored mid. Both Visual and Verbal students scored high for both L1 and ML, while at L2 visual scored high and Verbal scored mid. Reflective students scored higher than Active students at L2 and ML, but Active students were higher than Reflective students at L1. Visual scored higher than Verbal at L1 and L2, but lower at ML. For S-S, all styles scored high at all levels with the exception, L2 Verbal students scored medium and ML Verbal scored v. high.

- In terms of strength level analysis for students’ perception of S-I importance, Visual students show stronger preference towards this type of interaction than Verbal students at all levels. There are also some similarities existing between the strong end of the Visual style (moderate-strong) and the mild end of the Verbal style in both L1 and ML, except for L2 where there is quite noticeable that low percentage of Verbal students agree that using the web for S-I interaction is useful for their learning. Also, the mild end of the Reflective style scored higher at all levels than the strong end of the Active style (moderate-strong). ML displayed the highest level of use and perception of its usefulness, followed by L1, while L2 displayed the lowest level.

Learning preferences between CMLIs and TLIs

- In terms of learning preferences between CMLIs and TLIs, and the Choice between face-to-face and Virtual lectures, all styles scored high preference towards TLIs with Verbal students scoring very high preference towards TLIs. All styles scored low preference towards CMLIs with Verbal students scoring very low preference towards CMLIs. In terms of degree of augmentation of CMLIs with TLIs, All styles scored low in terms of CMLIs replacing TLIs, However, it is again noticeable here that Reflective learners followed by Verbal students show more will to use CML compared with Active and Visual students. Furthermore, all styles scored low in terms of TLIs with no CMLIs similar to the results of CMLIs replacing TLIs, all styles scored low in terms of TLIs complementing CMLIs, and all styles scored high in terms of CMLIs complementing TLIs. However Reflective students showed slightly more willing to accept that than other styles. On the other hand, all styles scored low for Choice between S-T CMLI than TLI, and all styles scored high for Choice between S-I CMLI and TLI with the exception of
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Verbal students who scored medium. Furthermore, in terms of choice between learning from books rather than computer screen, students' voluntary choice between learning through CML and TLIs in terms of learning from books rather than computer screen (S-I interaction), overall, low score by active and Visual students, higher for verbal and medium for reflective.

- Regarding the relationship between LSs and S-I interaction, Active learners showed very high level of use, perception for its usefulness, and also shown high learning preference towards certain aspects of S-I interaction such as preference to download lecture slides from the internet than writing notes in lecture. Reflective learners showed high level of use however lower than Active learners, also showed very high perception for its usefulness, and also shown high learning preference towards certain aspects of S-I. On the other hand, Visual learners showed very high level of use and perception for its usefulness similar to active learners, and also shown high learning preference towards certain aspects of S-I. Verbal learners showed high level of use and perception for its usefulness but lower than Visual students, but showed higher learning preference towards traditional aspects of S-I such as using books for learning rather than computers.

- For the LSs and its relationship with S-T, Active learners showed low level of use, high perception for its usefulness, but very low learning preference towards certain aspects of S-T interaction such as preference to communicate with tutor through e-mail rather than F2F. Reflective learners showed very low level of use (lower than active learners), high perception for its usefulness, but low learning preference towards certain aspects of S-T interaction such as preference to communicate with tutor through e-mail rather than F2F (however this result is higher than active learners). On the other hand, Visual and Verbal learners showed low level of use, high perception for its usefulness, but very low learning preference towards certain aspects of S-T interaction, however verbal learners were slightly lower than visual learners.

- For the LSs and its relationship with S-S Active learners showed high level of use and high perception for its usefulness. Reflective learners showed low level of use (lower than active learners) however high perception for its usefulness. On the other hand, Visual and Verbal learners showed medium level of use and high perception for its usefulness.
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- For the LSs and its relationship with the 3-CMLIs, all styles showed high score towards TLIs and low score towards CMLIs, however the exception is the verbal style which scored very high for TLIs and very low for CMLIs.

6.3.2 Phase two

The second phase considered specific settings to investigate the relationship between LSs and S-I, S-T and S-S interactions in terms of learning preference between CMLIs (non-voluntary) and TLIs. The findings of the first setting demonstrated that LSs seems to have some link, however small, with students' preferences towards using or learning SQL or QBE. The result indicated that Verbal learners had higher preference for using SQL compared to Visual learners, who showed a higher preference for using QBE. Despite that, the majority of students of both styles found it easier to learn SQL, of which they possess a higher level of existing knowledge than QBE. The results of the second setting also show that Reflective students scored higher overall mean access to WebCT learning environment during the semester compared to Active students and also scored higher frequency of access compared with Active students. On the other hand, generally Reflective students scored higher frequency of use of S-S interaction compared with Active students, while both Active and Reflective students had similar low scores of frequency of use of S-T interaction compared with other types of interactions. In terms of comparison between their learning preference between traditional and virtual lecture, Reflective students showed higher preference to CMLIs compared with Active students. Both Reflective and Active students showed total preference to CMLIs in terms of using the web to search for information rather than visiting the library.

In terms of WebCT Learning Environment, the results show that Reflective students scored higher overall mean access to WebCT learning environment during the semester compared to Active students and also scored higher frequency of access compared with Active students. Active students scored higher frequency of use of S-S interaction compared with Reflective students, while both Active and Reflective students had similar low scores of frequency of use of S-T interaction compared with other types of interactions. In terms of comparison between traditional and virtual lecture, Reflective students showed higher preference to CML compared with Active students. Both Reflective and Active students showed total preference to CMLIs in terms of using the web to search for information rather than visiting the library. Furthermore, the results also are quite interesting, as it shows change overtime, particularly indicates increase of
Reflective students than active, a point which was noticed to a certain extent in phase one between different groups, which will need further future investigation. Also similar to phase one, overall, students scored higher access to S-I than all other interactions, followed by S-S and S-T. However, Reflective students scored higher than Active students for S-I and S-S interaction, and similar in S-T. Contrary to phase one, Reflective students seem to score higher access than Active students which may indicate the effect of learning context between voluntary and non voluntary use of CMLIs. However, in terms of learning preferences between CMLIs and TLIs, Active students scored higher preference towards S-I and S-S computer based interaction compared with Reflective students. This may be explained as a consequence of the learning style itself as well as other factors such as computer background (Web), which shows that Active students reported higher score than Reflective students; in addition to that, higher percentage of Reflective students' first language is not English compared with active student. However, despite that, in terms of S-T, Reflective students showed slightly higher preference to CMLIs compared with active student. Furthermore, in terms of the choice between attending a lecture F2F or watching it as Virtual Lecture on the web/online, the results show that Reflective students showed higher (33.33%) preference to CMI compared with Active students (0.00%).

The overall results of both phases highlighted several important points. One, different LSs do exist amongst computer students with different variations of attitude towards the 3-CMLIs, therefore the importance of applying the right balance between the styles and their strength levels, and consequently applying the right balance between accommodating existing LSs and developing skills required by the course. Two, the importance of allowing for reflection to cater for Reflective students, appropriate and balanced use of multimedia to cater for Verbal and Visual students, through the use of the multimedia principle (Evans et al, 2002), Ainsworth (1999), and Mayer (2001) and Rieber (2002). Three, the need to increase active learning elements that usually lack many course designs in order to cater for active learners and to allow students to respond to activities and receive feedback as an important part of CMLIs. Four, the importance of taking into account the learning environment has been highlighted, whether compulsory or voluntary virtual and its implication on (the intrinsic) level of use of the 3 interactions for each LS; the importance of taking into account difference between levels of study: that is, whether the student is at the beginning middle or end of course and its effect on students use of the 3 interactions; LSs strength levels; difference between students actual use and perception they hold of each interaction; as well as the degree of integration of CMLIs into TLIs, and its impact on students attitude towards CMLIs. Consequently this should lead to the maintenance of the
appropriate order of importance between the 3-Is that coincide with both LSs and tasks to be developed, taking into account other individual differences such as prior knowledge and its (intrinsic) implication on strength level for each learning style at different levels of studies, as well as the use of variety of Interactions and maintaining the appropriate balance between them in relation to LSs and skills to be developed.

6.4 Implications of the research findings on ILSs design

Drawing on the key findings, this study proposes a Learning Styles Interaction Model (LSIM) that relates LSs and other possible influential factors to students' attitude towards CMLIs (Figure 6.1). The model includes some elements from three models described in chapter two; but from the interactivity perspective of learning systems with a particular focus on LSs and the 3-CMLIs. One, Biggs' (1989) '3-P Model of Learning' in terms of the two influential components presage (personal and situational factors) that exist before starting a particular course of learning and the Process (approach the student adopt to learning tasks). Two, the TAM model (Davis, 1989) in relation to the influential factor on students' attitude towards the use of technology such as 'perceived usefulness'. Three, the Student Perception Model (based on O'Malley J and McCraw H (1999) and Rogers's (1995) Diffusion of Innovations model) in relation to the influential factors, characteristic of the student and perceived characteristic of CML, and prior educational conditions.

![Figure 6.1 LSIM Model](image-url)
It draws upon the finding possible relationships between factors, LSs-prior knowledge, LSs-Voluntary/non-voluntary choices of the use of 3-CMLIs and degree of augmentation between CMLIs and TLIs. This study also highlighted several interactivity design considerations (Table 6.3). One, the importance of use of multimedia for learning in terms of its relevance to the VV LSs, and the balance between them that is based on students' LSs profile, level of study, prior knowledge, and subject area. This can be achieved through the appropriate and balanced use of multimedia to cater for both Visual and Verbal students, taking account of multimedia principles described by Mayer (2001), Ainsworth (1999), Rieber (2002) and Evans et al (2002).

<table>
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<th>Interactivity Considerations</th>
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<td>1. Balanced use of multimedia</td>
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<td>2. Providing opportunities for reflection</td>
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<td>3. Injecting active learning elements</td>
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<td>4. Considering the nature of the learning environment and the degree of integration between CMLIs and TLIs</td>
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<td>5. Considering the different levels of study and LSs strength levels</td>
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<td>6. Considering the difference between students' actual use and perception they hold of each interaction</td>
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<td>7. Considering the degree of integration between CMLIs and TLIs</td>
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<td>8. Engaging the students</td>
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<td>9. Balancing between accommodating existing LSs and skills required to be developed by the course</td>
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<td>10. Considering learners' other individual differences</td>
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Table 6.3 Interactivity Considerations

For example, for S-I for Visual LSs, increase of visual elements based on the LSs profile exhibited by the students and skills to be developed and provide relevant visual representations whether static and/or dynamic such as animation, graphs, videos, and/or images. For S-I for Verbal LSs, allow for written words (textual presentation) as well as spoken words (sound), provide summaries or outlines of course material, and allow learner to write points learned in their own words. While for S-S and S-T, allow, for example, the use of videoconferencing where students communicate both visually as well as verbally through the use of picture and word.

Two, allowing for reflection to cater for Reflective students, for example, through asynchronous interactions using the discussion board and or e-mail as well as use of self-assessment questions. It is essential to provide opportunities for reflection not only to engage Reflective learners in the learning process, but also to combat the passivity of learning systems, something that is not
favoured by Reflective or Active students. However, the degree of reflection allowed should be, as previously discussed, in accordance with factors such as the LSs profile exhibited by students, skills to be developed, level of study, prior knowledge, and subject area. For example, for S-I interactions, enable reflection through pauses through which the learner can do self-assessment questions, quizzes, and allow for asynchronous S-S interactions such as discussion board activities. Similarly, for S-S and S-T, allow for asynchronous interactions through activities using discussion board to help understanding and evaluation of subject as well as using e-mail.

Three, the increase of active learning elements that are usually absent from many course designs in order to cater for Active learners and to allow students to respond to activities and receive feedback as an important part of CMLIs. The results showed higher percentage of the Active LS compared with the Reflective one, which indicate the importance of increasing and providing Active learners with ways to engage them in the learning process through injecting activities that helps in developing required skills, and to apply what has been taught. This is done in order to combat the passivity of many courses, something that is not favoured by many Active or Reflective students. For example, for S-I engage the learner in interactive self-assessment questions that allow for learners’ responses and provide correlated and meaningful feedback, and through searching the Internet for relevant information. For S-S and S-T, allow the use of asynchronous interaction (for example, the discussion board and e-mail) and synchronous interaction (for example, chat room) for group assignments, discussions, brainstorming, and problem solving exercises.

Four, highlighted is the importance of taking into account the learning environment, whether compulsory or voluntary virtual and its implication on (the intrinsic) level of use of the 3-CMLIs for each LS. This principle may have an effect on the students’ degree of use of CMLIs in relation to factors such as LSs strength level, possible effect of learning environments on students’ LSs, whether VDLE and/or TDLE, and whether the CMLIs are asynchronous and/or synchronous. Whether the learning environment is TDLE or VDLE, this may influence students’ attitude, as well as the degree of integration between CMLI and TLIs.

Five, the importance of taking into account difference between levels of study, that is, whether the student is at the beginning middle or end of course and its effect on students use of the 3-CMLIs. Also, the mild level of LSs should be treated as a more flexible and balanced compared with the strong and moderate levels LSs (Felder, 1993). The importance of this principle in terms
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of ILSs design, lies in the possible change of students' LSs and/or its strength level at different stages of students' learning or as they progress through a particular module. This highlights the importance of flexibility and adaptivity of the system. Six, taking into account the difference between students' actual use and perception they hold of each interaction. This is important in terms of determining possible indication/s of any negative perception or attitude towards CMLIs that might suggest design modification to cater for different LSs and skills to be developed. The findings indicated that, S-I interaction is used and appreciated more than other S-S and S-T interactions which imply taking this into account in any interactivity design, in terms of maintaining the relevant and appropriate order of importance between the 3-CMLIs that coincide with both LSs and tasks to be developed to achieve a more balanced design.

Seven, the degree of integration of CMLIs into TLIs and its impact on students' attitude towards CMLIs. Consequently this should lead to the maintenance of the appropriate order of importance between the 3-CMLIs that coincide with both LSs and tasks to be developed. It also emphasised that LSs profile should be considered along with other variables of individual differences such as prior knowledge and its (intrinsic or dominancy) implication on strength level for each learning style at different levels of studies, as well as the use of variety of interactions and maintaining the appropriate balance between them in relation to LSs exhibited and skills to be developed for a particular module period of study.

Eight, engaging the students, through the use of variety of CML interactions and through maintaining the appropriate balance between them in relation to LSs. Interactions should vary in their form and nature to keep the learner interested, through incorporating variety of the 3-CMLIs according to nature of the subject, students LSs profile, and skills required. It is important to allow learners to respond and receive feedback whether through asynchronous and/or synchronous interactions to accommodate both Active and Reflective students as an important part of the 3-CMLIs.

Nine, the importance of balancing between accommodating existing LSs and skills that are required to be developed by the course. Ten, Identifying the LSs' profile of students (Learner component of an ILS) should not be treated in isolation from, for example, other individual differences such as prior knowledge (which are subcomponents of the 'Learner' component of an ILS), the objectives and aims of the course (Subject Information component of an ILS), technology to be used (Technology component of an ILS), and different instructional approaches
(Pedagogy component of an ILS) without advocating a particular pedagogical model, but advocating flexibility to incorporate variety of pedagogical approaches to suit and accommodate different students' needs without ignoring the skills to be developed by different subjects.

Furthermore, each LS should be considered in conjunction with other styles, not in isolation, to avoid any upset to the balance. For example, looking at techniques that can accommodate more than one LS as well as developing collaborative skills, such as posting activities on the discussion board, that on one hand encourage the use of S-S asynchronous interaction, where active LSs can actively engage in the learning process, while Reflective students reflect and engage in the activities. However, caution has to be taken if synchronous interaction such as chat is used to accommodate Active LSs. A log of the interaction detail will probably be beneficial for Reflective LSs. Further discussion of this issue will follow later on when talking about the proposed interactivity design model and also in the 'limitations and further research' section.

Finally, based on the above findings and implications, and LSs theory (chapter two), it may be useful to suggest and propose a preliminary process design model that is specific to LSs, that may be used as basis for a more comprehensive model and framework to guide the development of ILSs in terms of its adaptability and adaptivity (Figures 6.2 and 6.3) that incorporate two main concepts, the balance as well as the blend. The 'blend' concept relates to learning that integrates various LSs, rather than the integration of traditional learning and CML. The 'balance' concept is related to balance between the skills to be developed and LSs to be accommodated. This highlight the importance of the balancing concept in relation to the blending of instructional design approaches for the purpose of accommodating different LSs in conjunction with developing skills required by the course. It not only considers a blended approach that constitutes adapting to learners' different LSs and developing learning skills required by the course but also considers maintaining a relevant balance between them taking into account the cohort involved, subject area, and role of CMLIs in terms of whether they form a dominant part of the course or only a supporting role.
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BBM Model and Framework

3. Student considerations (Learner Component): Analysis and Diagnosis Activities

- What tools are to be used to determine the LSs profile?
- What is the % of each LS exhibited?
- What is the strength level of each LS (Strong-Moderate-Mild)?
- At what stage of the course the LS profile is obtained (beginning-Middle-End)?
- What are students' actual use and perception of the 3-CMLIs?
- What are other IDs (Individual Differences) that need to be taken into account (eg Prior knowledge)?
- To what extent do the 3-CMLIs are to be integrated with TLIs in the course?

4. Students' Profile

- Identifying LSs to be accommodated based on the LSs profile (including proportions and strength levels); perception, actual use of the 3-CMLIs and learning preference profile (noting time data are obtained); other IDs that should be taken into account (such as Prior knowledge).
- Determining which proportion/s of course to accommodate these LSs.

5. Balance & Blend Operation

Determine degree and extent of matching / mismatching the exhibited LSs.

2. Skills to be developed: identify goals and skills that need to be developed. Determining which proportions of course to achieve the learning goals/skills to be developed

1. Course considerations: establish module's aims, objectives, and other related details related to the ILS components (Pedagogy, Information and Technology).

6. Interactivity Design Considerations

- Engaging the students through applying the relevant combination and % of each interaction (S-S, S-T and S-I) in terms of the learning system design in relation to traditional learning methods used.
- Engaging the students through applying the relevant combination of picture and words for S-I interaction.
- Considering learners' other individual differences that might influence student choices.
- Considering the different levels of study and LSs strength levels.

The blended approach also takes into account changes in LSs that might occur as a course progresses and other individual differences such as prior knowledge. This is achieved by including elements of the less dominant LSs at different levels to allow for changes as well as a balance between the skills to be developed and accommodating learners existing LSs. This essentially includes six main activities (Figure 6.3):
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- One, looking at course considerations, which involve the ILS components, discussed in chapter 2 (Subject Information component), and establish module's aims and objectives.
- Two, identify the skills that need to be developed and determine which proportions of course to achieve them.
Three, the analysis and diagnosis activities, which form an important part of the 'Learner' component of the ILS. For example, it includes consideration of tools to be used to determine the LSs profile and students perceptions; a snapshot of % of each LS exhibited including strength level of each LS (Strong-Moderate-Mild) and students' actual use and perception of the 3-CMLIs; stage of the course the LS profile is obtained (beginning-Middle-End); other IDs (Individual Differences) that need to be taken into account (for example, Prior knowledge); extent to which the 3-CMLIs are integrated with TLIs in the course.

Four, identifying LSs to be accommodated based on the LSs profile (including proportions and strength levels); perception, actual use of the 3-CMLIs and learning preference profile (noting time data are obtained); other IDs that should be taken into account (such as Prior knowledge); determining which proportion's of course to accommodate these LSs.

Five, the Balance & blend Operation to determine degree and extent of matching/mismatching the exhibited LSs. The Balance and Blend operation represents an important part of the model, however, it is a complex issue that should involve all the components of ILS, and the model does not claim or suggest a solution for achieving such balance as it only investigated the LSs subcomponent of the 'Learner' component of ILS. However, it puts some suggestions forward for achieving that, one of which is based on Biggs' (1999) contextual approach described in chapter two, through combining elements of both assimilation and accommodation.

![Figure 6.4 The balancing concept of the BBM](image)
For example, students with mild preferences (that is, more balanced according Felder, 1993) can be viewed as having similarities and can easily adapt to different learning approaches, whilst students with stronger LSs can be viewed as having differences that needs to be accommodated or assimilated according to LSs exhibited, and goals and objectives of subject been taught, within the whole instructional-learning system design. Another example, through the use of the discussion board (DB), in accordance with students’ LSs profile and skills to be developed, for group activities will not only provide a blended approach (by accommodating Active students as well as developing problem solving skills for both Active and Reflective students), but will also accommodate Reflective students through allowing for reflection through its asynchronous nature of interaction. Furthermore, a change in the nature of interactivities to allow, for example, students to critique their work, can accommodate the change in LSs that occurs as a course progresses, for example, towards more reflective style. For example if the skills to be developed (SRD) involve a high percentage of active learning (for example through group work or problem solving activities) and the LSs profile matches (that is, a high percentage of Active students and a low percentage of Reflective students), the suggestion will be a ‘Must Match’ situation (Appendix 12). That is, it will require a match between LS and SRD, mainly active learning domination blended with reflective principles, and will need monitoring progress of students and apply modification as necessary. On the other hand, if the SRD are described as high percentage of active learning, while LSs are high Reflective and low Active, this will be more problematic case, indicating a mismatch between LSs and SRD. Careful blended design will be required, mainly active learning to achieve required skills, but integrated with more opportunities for reflection, in addition to the need for monitoring progress and applying modifications as necessary.

Six, the interactivity design considerations that are based on the research-based design consideration discussed above. It is concerned with incorporating interactivity through engaging the students through relevant combination and % of each interaction (S-S, S-T and S-I) in terms of the learning system design in relation to traditional learning methods used; engaging the students through applying the relevant combination of picture and words for S-I interaction; considering learners’ other individual differences that might influence student choices; and considering the different levels of study and LSs strength levels.
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6.5 The interactivity concept and the ILS components

The findings and implications highlighted in this research have some implications on the interactivity concept and definitions reviewed in chapter two, which described interactivity of learning systems as that, it incorporates features and mechanisms that provide feedback, allow for learner response, active engagement of the learner, allow for reflection, use of multimedia, and include variety of interactions. Whilst the findings support such features, it stresses and highlights the importance of taking into account the actual students involved in the learning process including their differences, learning preferences, level of study and LSs. It also highlighted the importance of considering the balanced and blended concepts discussed above, for example, the learners should feel that such features are balanced and blended in a way that they can relate to and not feel alienated by, particularly in terms of the use of the 3-CMLIs. This leads to the importance of accommodating students' differences, one of which is the LS, but in terms of their actual LSs profile rather than a randomly mix of LSs design, while at the same time taking into account other individual differences (such as for example prior knowledge) and the ILSs components. Therefore, this study defines interactivity of learning systems as, the engagement of all learners in the learning process (whether Active, Reflective, Visual, Verbal or else). In other words, this entails that, the Active learner should have enough opportunities for active engagement, the Reflective learner should have enough opportunities for reflection, the Visual learner should have access to pictures (dynamic and/or static) and the Verbal learner should have access to words (written or spoken). Whilst, this definition supports literature (chapter 2), for example in terms of allowing for active engagement and reflection, it makes a distinction between them in that, the engagement of Reflective learners may differ from the engagement of Active learners, and considers that engaging Reflective learners is an interactive process that does not in any way mean passive learning, and that for the learning system to be interactive it should engage both Reflective and Active learners.

In learning systems terms, this definition may be achieved through the interaction between the components of the learning system with careful consideration (the balanced and blended concepts discussed above) of students' actual learning preferences (Learner component) taking into account other components of ILSs (Pedagogy, Subject Information, and Technology). The findings highlighted the importance of including a dynamic component to the learning system described in chapter two, namely the 'Interaction Design' component which represents the interactions between all components (in deciding for example, the way a course of study is to be
delivered in terms of technology to be used, types of learning interactions relevant to both students’ differences and skills to be developed) and may act as a balancing component of the system and the determiner of its interactivity level (based on students’ profile obtained and other considerations from the other components), and includes the balancing and blending operation described in the BBM Model. This is to encapsulate the importance of the interaction and cohesiveness between all the components rather than treating them as static or isolated components. The proposed ILSM model (Interactive Learning System Model) incorporates elements from this research’s key findings, learning theories and the ILS structure (chapter 2), and the BBM model described in this chapter (Figure 6.5).
6.6 Summary

This chapter discussed and reflected on the results presented in chapters four and five in relation to the research questions raised in chapter two and summarised the meaningful results in terms of LSs profile exhibited by students, relationships with 3-CMLIs, other factors that could have some influence on them, and possible implications on ILSs design. It provided evidence to support the differing views of learners of different LSs, evidence of common attitudes towards certain CMLIs, and statistical significance evidence of the relationship between the AR dimension and the use of S-I and S-S interactions. It also highlighted some of the limitations of using the LSs in isolation or as the sole predictor of student’s attitude, and the importance of considering other aspects of students’ individual differences such as the student’s prior experience, stage of learning as well as the nature of the learning environment in use. Implications of the findings in terms of interactivity considerations to guide the planning and design of ILSs are suggested, and an initial layout of an interactive design model is discussed. The next chapter will further reflect on these points in terms of the contribution of this research to the field. It will link the main issues arised from the literature review with the interpretation of the research results in relation to its aims and objectives. It will conclude this dissertation with a discussion of the research limitations, recommendations and further educational research.
Chapter 7- Research Conclusions and Contributions

7.1 Introduction

The ultimate objective for educational research in the area of CML (Computer Mediated Learning) is to optimise instructional designs in order to maximise learning opportunities offered through CMLSs (Computer Mediated Learning Interactions). It is common, however, for course design to become technology driven rather than to support and meet students' needs and very often educational institutions choose to apply technology to their courses because of, for example, its availability, convenience and/or political and management pressure. Theories and models linking technology to learning and teaching are often over-enthusiastic and pursued with uncalculated forcefulness, particularly in relation to students' differences and LSs. Very often instructional designs are influenced by factors such as the designer's personal preferences, experience, familiarity with certain technologies, and there is often a mismatch between instructional objectives and learners' learning differences. As learners differ in many ways, have different learning styles (LSs), and perceive learning interactions differently, for the learning process to be interactive for the learner, it is important to raise designers and teachers' awareness of such differences and to call upon them to take necessary steps of considering actual learners' LSs and individual differences in course design. This study has sought to raise such awareness in order for instructional designs to be driven by a closer encounter of the real users of such systems rather than any inherited biases or inflexibilities that have little to do with the target learner and/or actual subject skills to be developed.

However, the interactivity and adaptation of learning systems to students' differences is a challenging task that faces designers of such systems. The complexity of human learning, as a product of such differences, in addition to the diversity of learning tasks, make it unrealistic aim to find one universal design that fits all learning situations, all learners, and all instructional objectives. The motivation for this study therefore has been to explore some of the complexities that surround the analysis and design stages of ILSs (Interactive Learning Systems) developments. It contributes to the body of knowledge about students' learning differences and their relationship to different aspects of learning interactions that may inform the planning and design of more adaptive and adaptable learning systems that are more interactive and sensitive to students' differences which may in turn help to improve students'
attitude towards the use of such systems for learning and the way they are perceived. As such it offers an initial investigation, exploration and practical examples of students use and perception of CMLIs in relation to their LSs and consequently gives some insight into the complex array of processes that contribute to the dynamics of ILSs design. Drawing on LSs theories (chapter two), which have been used to explore how individual learners approach learning, as well as different 'Learning Interactions' in relation to Interactive Learning Systems (ILSs), the work that has been undertaken in this research has made its contribution to the field in that it represents the first investigation of 'Learning Interaction' as a core concept of ILSs' design in relation to students' AR (Active-Reflective) and VV (Visual-Verbal) LSs, in both TDLE (Traditionally Dominated Learning Environment) and VDLE (Virtually Dominated Learning Environment) from the viewpoint of those using these systems (learners) rather than those designing them (teachers and/or designers). The Felder and Soloman Index of LSs (1999) which is based on Felder-Silverman model (1988) has been adopted in this study. The research undertaken in this study is the first to adopt this instrument in the field of information systems and computer science education, in conjunction with the use and perception of the 3-CMLIs questionnaire.

Some studies have argued the importance of interactivity for CML whilst others have argued the importance of considering the users when designing learning systems. However, few studies have touched on or made a link between, both interactivity and adaptation concepts in terms of actual users' (learners) use and perception of CMLIs, and none have looked at the relationship between such use and perception of the 3-CMLIs and what are often ignored aspects of student's learning, namely the AR and VV LSs from the interactivity perspective of learning systems. Furthermore, in most cases, proposed design principles, models or frameworks do not take into account actual studies of learners' different LSs or empirical knowledge of their learning preferences. This study is therefore innovative in that it links interactivity of learning systems with both the learner's learning preferences in terms of the 3-CMLIs in order to assist in design decisions, whether for accommodating and/or developing certain learning skills, as important knowledge consideration for any ILS analysis and design. As such, it may assist designers and teachers in establishing research-based principles, guidelines for CMLIs design and a framework that are based on actual users of the system to guide the development of ILSs. Finally, this study redefines 'interactivity' of learning systems in the light of the findings with a particular focus on the users of the systems (learners' perception and LSs).
The following section explores what all this mean. It reflects on the contribution made by walking through the key research findings and implications, in light of the main objectives described earlier in the dissertation (chapter one), and looks at the extent to which the common attitudes exhibited by certain LSs towards CMLIs should be considered as fixed or immutable for different groups of learners. Finally the dissertation concludes with a discussion of the study's limitations, and recommendations for further research are made.

7.2 Key research findings and implications

Review of literature and research design

The dissertation reviewed literature on interactivity of learning and identified the main components of learning systems. These comprise Information (including course content), Pedagogy, Technology, and the Learner (chapter two). Literature on LSs, as an important subcomponent of the 'Learner' component of a learning system, raises fundamental issues in relation to interactivity and LSs, and it is argued here that if we are to design ILSs then a more student-oriented approach to analysis and design should be implemented. It is also argued that little has been done on the development of clear guidelines for ILS developments, and that in most cases the design is not based on actual studies of learners' different LSs or empirical knowledge of their learning preferences. The review also raised issues such as to what extent the styles exhibited should be accommodated, and to what extent the non-exhibited or weak styles should be considered for developing necessary skills.

Data was collected through the examination of students LSs, perception and use of CMLIs, and learning preferences between CMLIs and TLIs (Traditional Learning Interactions) of undergraduate and postgraduate students taking undergraduate or postgraduate courses in computing at a UK university (see chapter three). A mixed qualitative and quantitative research approach was adopted to provide a descriptive and exploratory picture of what is going on (a snapshot) in terms of 'opinion' as well as 'proportion' of each style. This was to obtain students' opinion and feelings towards using CML and not to put them under an artificial controlled environment and pressure, or to impose pre-conceived ideas of the researcher. The descriptive and evaluative nature of the research dealt with complex human issues related to e-learning. Having said that, the approach used is not without limitations, which will be discussed in the limitations section later on. Triangulation was incorporated through data collection using successive questionnaires, the Instrument of LSs and observation. The collected data was analyzed (chapters four and five); the hypotheses and the relationships were discussed and examined between the concepts in a single social
The first objective: explore and describe the LSs profile of students

Exploring the LSs profile of computing students was one of the fundamental objectives of this research. It sought to investigate LSs, Active (who prefer active engagement in the learning process perceive different types of CMLIs), Reflective (who prefer learning through introspection), Visual (who prefer learning through use of visual elements perceive different types of S-I presentations), and Verbal students (who prefer to use of textual elements). Some of the key findings relating to this objective was summarised in Chapter six (Table 6.1). In order to do so, its answers to the following questions were required. What is the LSs profile of the students? Does it vary amongst different groups? Is there a common LSs profile exhibited? Did any further issues arise from this investigation? In this respect, the research found that high proportions of computing students exhibited Visual and Active LSs at all levels, that is, level one (L1), level two (L2) and Masters level (ML), compared with Verbal and Reflective styles. As such, it gives an indication of the preferred LSs that target students may have in common (computer students). These results indicate that computing students tend to prefer the Visual LS. It raises the question as to whether such variations are related to the subject area being studied or to the difference in samples used, a point that will be discussed further in the ‘limitation and further research’ section. Whilst, this result emphasised the importance of visual presentations and active learning, it further adds a new dimension, particularly in relation to students taking degrees in the computing field from the LSs perspective, a point that is often ignored in the planning of interactivity for ILSs design.

This finding has reinforced and highlighted the issue that whilst the majority of students are Visual and Active, the majority of CML systems are generally designed in a non-active (or passive) ways, and predominantly Verbal. A mismatch that could lead to less satisfied students and, as described by Felder and Silverman (1988), could lead to poor performance and frustration if not addressed at the early stages of a course. This supports Norman (1988) in terms of the inclusion of both activities and reflection, which consequently will help both Active and Reflective students and achieve a more interactive learning system. A furthermore contribution to the knowledge in the field is that, some overlap between Visual and Active computer students exists and that a higher percentage of Visual students were Active rather than Reflective. Again, these results may reinforce the necessity for both visual presentations and active learning processes to be combined for ILSs design, without ignoring other LSs.
Despite the similarities shown by all three groups (L1, L2, and ML) in terms of the order of LSs (that is, Visual, Active, then Reflective and Verbal), variability did exist in terms of the percentage of each LS and its strength levels amongst the different groups. Whilst this may be due to differences in the composition of each group (for example, in terms of age, first language, gender, computer and internet/web background, and other social and differences in abilities), it may also indicate change as learners progress through the course, differences in prior knowledge, not to mention the time the data is collected (that is, at beginning, middle, or end of study). For example, the tendency towards the Visual style appeared to get less the higher the level (chapter four), and vice versa, that is, the Verbal style increases as the level goes up. This to a certain extent supports and reinforces other research in terms that the need for visual presentation becomes less important as the level of prior subject knowledge increases (Mayer, 2001), and that the type of representation that is best for learning shifts over time (Rieber, 1996). However, it also adds another dimension to that in terms of looking at different presentations from the VV LSs perspective, for the purpose of ILSs design. This was further enforced to a certain extent in phase two of the study, where it was shown (chapter five) that students who had a low level of knowledge of subject area prior to starting the module tended to have slightly higher preference for the Visual learning style and a low preference for Verbal learning compared to students who had a higher level of knowledge.

On the other hand, it appeared that Visual students' perception of S-I interaction in terms of the 'use', 'difficulty', and 'easiness' of learning using textual presentation (TP) seemed to be influenced to a great extent by their prior knowledge as a dominant factor, showing that the majority of students found it easier to learn using TP including Visual students (moderate-strong) rather than graphical presentation (GP). This raises the question as to what extent does prior knowledge affect LSs or learning strategies (ways that are developed by learners to adapt and deal with different learning tasks). This issue will be discussed further in the 'limitation and further research' section. A similar example to the above showed differences and change in LSs, namely that the tendency towards the Reflective LS appeared to increase by the end of semester period of study compared with the beginning of the semester (chapter five) that may be interpreted as change over time. Moreover, but with a lesser degree, the tendency towards the Active style appeared to get slightly less the higher the level becomes, and the Reflective style increases slightly as the level goes up (chapter four), which was particularly noticeable between L1 and L2. Another example that was observed of such variation, but in terms of LSs strength level, was that the proportion of students with strong LSs, in contrast to mild styles, was wider in L1 and ML and milder or more balanced in L2. That is despite the differences in population composition of L1 and ML (in terms of age, first
language, gender, and general computer experience) and that both levels reported similar high internet/web background. This may be interpreted that both L1 and ML at the early stage of their course (first semester, when the data was collected) compared with L2 (third semester, when the data was collected), which may indicate that as the students' progress through the course, their strong LSs' tendencies become milder or more balanced. This is a particularly important finding that adds another dimension to the research in this area in terms of the extent to which LSs can be considered as fixed or immutable for different groups of learners at different stages of their learning or study. This point is essential for the purpose of ILSs in terms of the required flexibility and adaptivity of the system as the learner progresses through a particular module period of study. It also raises the issue of the distinction between LSs and learning strategies and whether LSs change as students' progress through the course and whether the instruments used take that distinction into account. This issue will be discussed further in the 'limitation and further research' section.

The second objective: explore and describe possible common attitudes towards the 3-CMLIs for different LSs.

Exploring possible common attitudes towards the 3-CMLIs for different LSs was the main focus of this study. Some of the key findings relating to this objective was summarised in Chapter six (Table 6.2). It sought to answer questions to find out whether there are any indications of common attitude towards the 3-CMLIs for the LSs examined, whether there are any differences in their preferences for the two different contexts (VDLE and TDLE) and the extent that LSs can be considered as predictors of students' attitude towards CMLIs and whether any issues or questions arises from this investigation. It sought to test the validity of the hypotheses that, student's LS may be associated with student's attitude towards the use of 3-CMLIs, and explore students' perception, and learning preferences. It hypothesised that, some students with particular LSs are more prepared to use CMLIs than others.

The study has provided evidence to support the differing views of learners of different styles at different stages of their learning, in different learning environments, and with different computing background. It has found statistical significant evidence for an association between AR and high/low use of both S-I and S-S. However, the hypothesis that LSs can solely be used to predict students' attitude, or in other words can be treated independently of other factors contradict some of the findings. Nonetheless, it provided rich and complex answers to research problem. It helped in finding out more about students' attitude towards CMLIs and the extent to which students will be willing to use them with a particular focus on LSs. All LSs shared the same ranking order in terms of their use and perception of the 3-CMLIs, that
is first S-I interaction (highest use), second S-S (medium use), then third S-T interaction (lowest use). Whilst such a finding has provided empirical evidence of students’ use of each type of CMLI in terms of different LSs, it has also added to the research conducted in the area of CML in terms of raising an issue that is often ignored when designing ILSs, that is, related to students’ preferences between using different types of CML interactions, particularly in terms of its degree of integration into traditional learning. As with traditional lecture-based learning the S-I (Student-Information), S-S (Student-Student) and S-T (Student-Tutor) interactions are more integrated to a certain extent around the lecture compared with CMLIs, as well as raising the issue of considering both asynchronous and synchronous CML. These issues will be further discussed later on in this section and in the ‘limitation and further research’ section. The finding that all the LSs’ perceptions of the 3-CMLIs have been higher than their actual use (chapter six) provides further evidence that the differences in their use is not due to the negative perception of the value of such interactions for their learning. Furthermore, as described in chapter six, the match between the use and perceptions of usefulness in terms of the order of the 3-CMLIs supports Davis (1989) TAM model in relation to the influential factors on students’ attitude towards the use of technology such as perceived usefulness. It also confirms and supports Collis’s 4-E model (Collis et al, 2000), Goodhue (1995), (Welke and Konsynski, 1980), Keller’s (ARCS) model (Keller, 1983), and Campbell and Campbell (1999).

The study has shown that there is a common attitude for Active and Visual students, represented in their higher preference towards the use of S-I interaction compared to Verbal and Reflective students (chapter four). This may be attributed, as discussed earlier, to the tendency of Visual students towards active information processing, and that Active learners learn best by doing something physical with information, and Visual learners learn best through their visual senses and physical demonstrations (Felder and Silverman, 1988; Felder, 1993), which are the actions involved when students surf the web and download information. However, it can also reinforce the idea that the increasing multimedia nature of the web, through the use of more graphical presentations of information could be an element of attraction for Visual students. Another common attitude that has been demonstrated by Active learners was their highest use of both the S-T and S-S interactions, which support research in that Active students understand better through discussion and bouncing ideas (Felder and Silverman, 1988; Felder, 1993). Furthermore, one of the contributions of this study is that, it found statistical significant evidence for an association between AR strong end of the scale, and high/low use of S-I and that the proportion of Active LS with high use differs significantly from the proportion of Reflective with high use (see chapter 6). It also found
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statistical evidence that, relationship exists between AR strong end of the scale, and high/low use of S-S, and that the proportion of Active LS with high use differs significantly from the proportion of Reflective with high use. However, it found no statistical significant evidence for an association between AR strong end of the scale, and high/low use of S-T, which may be due to the lower use of S-T interaction as discussed above.

The study has raised and reinforced issues related to different learning contexts and environments. This has been demonstrated in that Visual and Active LSs have exhibited higher preference towards the use of CMLIs in TDLE, compared with Verbal and Reflective styles, while for the VDLE Reflective students exhibited higher preference towards the use of both S-I and S-S interactions compared with Active students. Whilst this may support other research in term of the influential role different learning environments may play (Nicol et al, 2003; Crook, 2002; Pincas, 2000), it may further indicate the effect of LSs strength level (chapter six) and possible effect of learning environments on students’ LSs. It also supports other research in the area in that the asynchronous nature of CMLIs investigated, may provide more opportunities for reflection, which seems to suit Reflective students in the VDLE rather than the TDLE, particularly in terms of S-S.

Despite the fact that the study found no significant differences between the LSs in terms of their choice between TLIs (Traditional Learning Interactions) and CMLIs (chapter four), it found that all LSs preferred CMLIs to augment TLIs rather than the other way round. Whilst such a finding supports previous research in terms of students’ preference for face-to-face learning compared to CML (chapter two), it adds a new dimension in terms of the Visual-Verbal and Active-Reflective LSs perspective and further indicate their preferred degree of CML augmentation. This is an issue that should be taken into consideration when designing ILSs in terms of the balance between different types of learning interactions on the one hand and the planned degree of augmentation between CMLIs and TLIs on the other.

The third objective: identify and discuss possible implications of the findings on the ILS design, in terms of possible interactivity design considerations and the proposal of a model to support its adaptability and interactivity.

It is essential to demonstrate how the key findings described above can be generalised or presented in a shape of design considerations to support the adaptability and adaptivity of ILSs. Figure 6.1 (chapter 6) presented the LSIM model that encapsulates key design factors that should be taken into consideration in the ILS design. The research described in this dissertation has shown the LSs profile of students studying for a degree in the computing field
indicated some variations between different groups and their attitudes towards the 3-CMLIs, which reinforces and signifies the importance of applying the right balance between LSs and their strength levels, and of consequently applying the right balance between accommodating them and developing skills required by the course to maximise the interactivity of the design. As discussed earlier (chapter two), designs are often not relevant to actual users of the system for a particular course at particular time and this indicates a mismatch between students' LSs, which according to this study are dominantly Visual and Active, and the way modules are generally designed, very often taught in a non-active (or passive) ways, and predominantly verbal. This study identifies ten implications of the findings on the ILS design to support its adaptation and interactivity, which may contribute to establishing research-based principles to guide the development of ILSs (chapter 6). Whilst some of these considerations have been realised in general terms in previous research, they are supported and emphasised by this study from different perspectives, namely the 3-CMLIs and the Active-Reflective and Visual-Verbal LSs, individual differences such as prior knowledge, and from the interactivity perspective of learning systems design.

Injecting active learning elements. Whilst much literature has emphasised the importance of active learning as a general learning concept (Graham et al, 2000; Rice et al, 1999; Alexander and Boud, 2001; Meyers and Jones, 1993; Brookes, 1997), this research has further added a new dimension in terms of its relevance to the Active LS, which, according to the research findings, constitutes a higher proportion than Reflective students. Therefore, it is essential to increase and provide Active learners with ways to engage them in the learning process through injecting activities that helps in developing required skills, and to apply what has been taught. This is done in order to combat the passivity of many courses, something that is not favoured by many Active or Reflective students.

Providing opportunities for reflection. Despite much literature emphasising the importance of allowing for reflection as a general learning concept (Laurillard, 2002; Evans et al, 2002; Lin et al, 1999; Mayes, 2001), this research has further added a new dimension in terms of its relevance to the Reflective LS. It is essential to provide opportunities for reflection not only to engage Reflective learners in the learning process, but also to combat the passivity of learning systems, something which is not favoured by Reflective or Active students. However, the degree of reflection allowed should be, as previously discussed, in accordance with factors such as the LSs profile exhibited by students, skills to be developed, level of study, prior knowledge, and subject area.
Engaging the students. This design consideration is very much related to the previous two. Whilst much literature emphasises the importance of engaging the learner in the learning process as a general learning concept (Alexander and Boud, 2001; Reeves, 1999; Park, 2003), this research has further added a new dimension in terms of its relevance to accommodating different LSs in relation to the adaptability and adaptivity of learning systems. As a result, its effect on the interactivity of learning systems, which can be achieved through the use of variety of CML interactions and through maintaining the appropriate balance between them in relation to LSs.

Balanced use of multimedia. Despite the fact that many design principles have been proposed in multimedia learning in terms of the importance of using multimedia for interactivity, and the application of different combinations of static and dynamic pictures in conjunction with written and spoken words (Mayer, 2001; Rieber, 2002; Evans et al, 2002; Ainsworth, 1999), this study adds another dimension in terms of emphasising the importance of the balance between them, based on students’ LSs profile, level of study, prior knowledge, and subject area not only for accommodating both the Active-Reflective and Visual-Verbal LSs but also for developing the required skills.

Considering the nature of the learning environment and the degree of integration between CMLIs and TLIs. Whilst some literature has emphasised the influential role different learning environments may play (Burke and Papadimitriou, 2002; Crook, 2002; Pincas, 2000; Klassen et al, 2001), this research further adds that this principle should be treated cautiously as it may have an effect on the students’ degree of use of CMLIs in relation to factors such as LSs strength level, possible effect of learning environments on students’ LSs, whether VDLE and/or TDLE, and whether the CMLIs are asynchronous and/or synchronous. Whether the learning environment is TDLE or VDLE, this may influence students’ attitude, as well as the degree of integration between CMLI and TLIs.

Considering the different levels of study and LSs strength levels. That is, whether the student is at the beginning middle or end of course and its effect on students’ use of the 3-CMLIs. Also, the mild level of LSs should be treated as a more flexible and balanced compared with the strong and moderate levels LSs. As previously discussed in this section, this is a particularly important aspect of the findings of this research in terms of a possible change of LSs and/or its strength level at different stages of students’ learning or as they progress through a particular module. A point that should be considered particularly for the purpose of ILSs design in terms of the importance of flexibility and adaptivity of the system.
Considering the difference between students' actual degree of use and perception they hold of each interaction. This is an important finding of this research in terms of its diagnostic nature for determining possible indication/s of any negative perception or attitude towards CMLIs that might suggest design modification to cater for different LSs and skills to be developed. Furthermore, maintaining the relevant and appropriate order of importance between the 3-CMLIs that coincide with both LSs and tasks to be developed is important to achieve a more balanced design. As indicated from the findings, S-I interaction is used and appreciated more than other S-S and S-T interactions, which imply taking this into account in any interactivity design.

Balancing between accommodating existing LSs and skills required to be developed by the course. This is achieved by identifying the LSs' profile of students including their strength levels through the use of appropriate instruments as well as identifying explicitly the objectives and aims of the course. This is an important outcome of this research as it not only emphasises the importance of taking into consideration the LSs and instructional strategies but also calls for an appropriate balanced design approach that is more sensitive to the LSs exhibited by students and the objectives and skills of the course to be developed. Furthermore, each LS should be considered in conjunction with other styles, not in isolation, to avoid any upset to the balance.

Considering learners' other individual differences. Despite that this research's main focus was on LSs, this research's findings have highlighted important issues one of which is that LSs should not be considered in isolation, but in conjunction with other individual differences' (For example, prior knowledge) degree of dominance, and possible implication on students' attitudes towards CMLIs and strength level of LSs (at different levels of study and in different contexts).

Developing a model and framework that guide ILSs development. In addition to the interactivity design implications or considerations described above (see also chapter 6), this study contributes to the body of knowledge of ILSs design in terms of laying out the first steps towards establishing a process model and framework (BBM), that is LS sensitive, to guide the development of ILSs (chapter 6-Figures 6.2 and 6.3), through incorporating and integrating LSs theories in the context of the ILS components identified in chapter 2, to help to achieve a more interactive ILS in terms of LSs sensitive designs (see chapter 6). Whilst several instructional models have been proposed (see, for example, Lin and Hsieh, 2001; De
Villiers, 1999; Keller, 1983), this study focuses on different perspectives, namely on learners' LSs and perception of CMLIs from the interactivity perspective of learning systems design. Moreover, it emphasises the importance of the balancing concept in relation to the blending of instructional design approaches for the purpose of accommodating different LSs in conjunction with developing skills required by the course. This study therefore suggests some interactivity design considerations (described above) that believes should be attributes of any learner-centred model of learning used, through applying different types of learning interactions, based on the proposed BBM model and the ILSM model (chapter 6) in a balanced way to both accommodate learners differences and develop skills required by subject of study. It not only considers a blended approach that constitutes adapting to learners' different LSs and developing learning skills required by the course but also considers maintaining a relevant balance between them taking into account the cohort involved, subject area, and role of CMLIs in terms of whether they form a dominant part of the course or only a supporting role. The blended approach also takes into account changes in LSs that might occur as a course progresses and other individual differences such as prior knowledge. This may be achieved by including elements of the less dominant LSs at different levels to allow for changes as well as a balance between the skills to be developed and accommodating learners existing LSs.

The fourth objective: re-visit the ‘interactivity’ concept and the ILS components in the light of the research findings in relation to users of the systems (LSs and learners’ perception).
Based on the interactivity definitions reviewed in chapter two, an ILS consists of a learning environment that incorporates features and mechanisms that provide feedback, allow for learner response, engage the learner, allow for reflection, use of multimedia, enjoyable and include variety of interactions. Whilst this study supports such features it further adds that such features should be integrated in the course design in a balanced and blended way; one which takes into account actual students involved in the learning process including their differences, learning preferences, level of study and LSs. In other words, from the learners' perspective, they should feel that such features are balanced and blended in a way that they can relate to and not feel alienated by, particularly in terms of the use of the 3-CMLIs. Interactivity is a complex concept. It is about accommodating students' differences, one of which is the LS. This is in terms of their actual LSs profile (rather than a randomly based mix of LSs design), while at the same time taking into account other individual differences (such as for example prior knowledge) and the ILSs components. Therefore, interactivity is more about engaging the learners in different types of learning interactions, through careful consideration of their differences, in a balanced and blended manner. As described in chapter
six, the research findings highlighted the importance of adding an important component to the learning system (see chapter 6), namely the *Interaction Design* component as a balancing component of the system and the *determiner* of its interactivity level based on students' profile obtained and the aims and objectives of the course of study. The ILSM was proposed in chapter six to encapsulate the importance of the interaction and cohesiveness between all the components rather than treating them in isolation.

### 7.3 Research limitations

All research has its limitations. Some of the limitations are related to subjects used in the study, data collection methods, and other general choices made. In terms of subjects, the study reported on students taking computer related degrees in a UK university. However, it is recognized that the results may not necessarily be applicable more generally to other courses, other universities and/or countries, in terms of students' LSs profile and/or their attitude towards the 3-CMLIs. Additionally, phase one of the study attempted to investigate general (non specific) students attitude towards CMLIs with no reference to a particular module, while phase two looked at a specific CMLIs contexts. However, it is recognized that students' attitude (phase one) towards CMLIs may vary between different modules, communication technologies used and according to different teaching styles. Furthermore, sample size varied between the different groups or levels of study (phase one) and smaller size for phase two, consequently the study is limited by this. Additionally, the findings have shown that students' LSs profile indicated higher percentage of Active and Visual LSs compared with Reflective and Verbal. Consequently, there was larger sample of Active and Visual styles, which may have had an effect on the result in terms of attitude towards the 3-CMLIs. Having said that, attempting to find equal sample size of each LS would not support the study objectives of exploring computer students' LSs profile and preferences.

With regard to the finding (section 7.2) that LSs may vary or be influenced by the learning environment, particularly in relation to TDLE and VDLE, two important points need to be taken into account. One, that the VL design (phase two) is closer to S-I interaction rather than S-T interaction. Two, the strength level of the LSs, that is in phase one, the population had a stronger tendency towards the Active style (strong-moderate) compared to phase two students. In addition, the population in phase one was far larger than in phase two. Consequently, this comparison between the two learning environments has to be treated with some caution.
In terms of data collection methods, the results of this study are based on using Felder and Solomon’s Index of LSs instrument (1999). However, it is recognized that the results cannot be claimed to be identical should other instruments be used instead. Furthermore, the 44-questions of the Index of LSs instrument was used in phase one, which measures all four dimensions of LSs. However, in the second phase, only 22 questions were used which measures only the dimensions in question (that is, Visual-Verbal and Active-Reflective) in order to reduce unnecessary time taken for completing the questionnaire. However, it is realised that each method may have its influence on the exhibited LSs profile. Moreover, the students’ self-reported questionnaires were designed to capture several aspects about students’ attitude towards CML in general and the 3-CMLIs in particular. It attempted to investigate and highlight common attitudes of different LSs. However, it was realised that a fewer elements would have been sufficient to address that purpose. Furthermore, the questionnaires were generally based on the students’ subjective judgment, interpretation and/or opinion of the degree of use of the 3-CMLIs and prior computing knowledge, and did not investigate the quality, purpose or nature of such interactions in relation to course of study. For example, the study has used the scale frequent, regular, sometimes and never to represent students’ use of the 3-CMLIs subjectively. However, it is recognized that there can be some vagueness about these terms, which may be reflected in the results.

In terms of limitations related to other choices made, this study explored only the VV and AR dimensions of LSs using Felder and Solomon’s Index of LSs instrument (1999). The study also focused mainly on LS, however, information about other individual differences (such as age, gender, English language, and prior knowledge) had limited use as background information about the student population (chapter three). However, the study realises that further exploration of such individual differences or contextual factors and their interaction can provide essential information to further enhance and strengthen the contribution made. It is also recognised that there are other LSs (such as Intuitive-Sensing and Global-Sequential), as well as other aspects of individual differences (such as motivation, culture, social and special needs) that may have influencing roles on students’ learning.

Whilst, the observation conducted in phase two indicated that there was a possible change of LS between the beginning and the end of semester (through the application of the ‘Index of LSs’ instrument), it is recognized that applying the instrument twice within a short gap between the two measurements (three months) may influence students answers due to familiarity with the instrument. A longer gap perhaps might have been preferable to reduce the possibility of students becoming familiar with the elements of the instrument.
Furthermore, the analysis of the results included both the overall LSs (including strong, medium and mild) as well as looking at some aspects of each strength level individually. However, it is possible to investigate only the strong level of each LS in isolation, as this may give clearer results of each style's attitude and behaviour. Furthermore, the research investigated 'accommodating' LSs issues for the purpose of ILS design. However, it did not look at different subject types in any detail, therefore has not explored the developing issues related to skills to be developed related to different subjects and the implications of that in the ILS design including HCI issues in relation to usability and navigation design, as this was out of the scope of this study. Furthermore, the study has used limited CHI-SQ statistical significance tests for students use of the 3-CMLIs and recognises that the use of more statistical modeling and tests can help reveal further underlying relationships and strengthen the detailed analysis of multi-variant relationships between the factors (Reflective, Active, Verbal, Visual, S-I, S-S, S-T, L1, L1, L2, ML).

7.4 Future research and recommendations

The results support some theory from literature mentioned in chapter two, that there is still much to be learnt about CML (Foley and Schuck, 1998; Hase and Ellis, 2001), to understand about how to use ICT education (Taylor, 2004), and that instructional design should not only be concerned with delivering information to learner, but also with the efficient way information is presented to engage the learner in the appropriate cognitive processing to promote effective learning (Mayer, 2001). It also supports some elements of Rieber (2001, p.3) argument that learning environments should be treated with some caution, and there are limits to each learning environment both in 'what can be learned' and 'whose learning will be supported most' and that the complexity of human learning makes it difficult to identify 'which learning resources are appropriate for which people' (pp3-4). The findings agree with Tearle (2003) that the process of identifying and structuring the necessary pedagogic and design framework is quite complex, particularly when taking into consideration different LSs (Jones et al, 1997).

The findings also agrees that some problems have been linked with learning styles theories (Curry, 1990) in terms of the confusion surrounding their definitions, whether measuring LSs which are fairly fixed for the individual, or learning strategies which are developed to adapt and deal with different learning tasks to make use of one's cognitive style effectively (Riding and Rayner, 1998). Consequently, this could have an effect on the degree of the reliability and validity of instruments used. It also suggests that the extent to which the styles exhibited
should be considered as fixed, should be treated with caution and other considerations such as prior knowledge, degree of choice between voluntary and non-voluntary, and reliability of LS instrument used. Furthermore, it suggests that the extent to which the styles exhibited should be accommodated depends on the strength level and skills to be developed by the course of study.

Further research will be needed using a larger size sample of each LS in order to further investigate students' attitude towards the CMLIs and find out whether (if at all) there are any differences in the results so far obtained. This research has used a reasonably newly developed instrument (the Index of LSs). Exploring other LSs instruments will be required in order to find out in what way (if at all) the choice of instrument has affected the results so far obtained. Moreover, investigation of different LSs instruments in terms of a distinction between LSs and learning strategies is realised to be a beneficial attempt to remove some the vagueness surrounding them in terms of degree of change. Also, some refining to the questionnaire will be necessary to both more accurately determine students' perceptions, use, and learning preferences as well as applying more rigorous tests to determine more precisely their level of prior knowledge. Further research will also be required to include longitudinal investigation of learners LSs and learning preferences to explore change over time. This will likely involve a wider population including undergraduate learners, other courses, universities and countries as well as applying statistical significance tests in a wider scale to further investigate the strength and reliability of relationships between the different variables. Further research is also needed to investigate other LSs dimensions for a more comprehensive exploration of learners' differences (such as Sensing-Intuitive, and Global-Sequential), and also investigating other individual differences such as gender, prior knowledge, special needs, motivation and language fluency in relation to LSs. Furthermore, investigations of contextual or situational factors such as mood, idiosyncrasies, fashion, and emergence may also add an often-ignored dimension in relation to the student's attitude towards CMLIs. Future work will look in more details at the mobilization of interactions and the concepts of fluid interaction and mediation (chapter two), in comparison with non-mediated or traditional interactions (Sørensen and Pica, 2003), in relation to LSs and the attitude towards 3-CMLIs.

The results of this study raised several questions that require more investigation of other factors and possible influences that have not been the focus of this research, which may contribute to use of CMLIs. These include usability, accessibility and cost, in addition to investigating students' performance or learning outcomes in relation to CMLIs' use, and LSs profile of students taking degrees in computing field in comparison with non-computing ones.
This study has laid out the first steps towards establishing an interactive design model and framework, however further work is needed to establish a design model and/or framework that is more comprehensive, practical and tested. Moreover, further work is required to establish methods for achieving the appropriate balance between accommodating LSs and developing required skills, which should represent an important part of the model.

Although the implications or design considerations established may provide a basis for a wider guidelines and evaluation criteria for ILS, they do not constitute by themselves a comprehensive set of principles. They include general design considerations which address some elements of interactivity of ILSs but do not attempt to investigate in details all the underlying architecture of each component of an ILS (that is, the learner, information, interaction, technology and pedagogy), but are only concerned with some elements of the 'interaction' and 'learner' components. Moreover, the study looked at the interactivity notion of the design through the incorporation of the 3-CMLIs as a core issue for better learning systems that try to focus on engaging students in the learning process. This is sought through looking at students' learning preferences in terms of LSs and consequently, this may help understanding of issues related to the adaptation of the design of learning systems. More investigation of the technology side of interactivity will also be needed in future studies.

The study looked in general terms at the 3-CMLIs and did not investigate the distinction between the presence and absence of any of the 3-CMLIs in the learning environment in terms of its learning value. Furthermore, this research looked at students' attitude in terms of use, perceptions and preferences that concern their learning interactions through such systems. But, that said, it does not claim with any certainty (as learning through CMLIs has not been measured before and after or compared with traditional methods) that so doing makes much difference in student learning. However, this does not negate the value of looking at perceptions and learning styles and other individual differences, as we need to ensure that we understand the wider picture with regard to learners and learning, that is, what learners actually do, feel or like, as a result, of whatever interventions we do to the learning design. It did not however, investigate students' performance or learning outcomes, neither was an attempt made to evaluate or design web-based courses nor did to investigate in depth cognitive issues relate to students' personal learning preferences. An exploration of such elements would further contribute to the field knowledge in this area. This study included some elements of comparison between CMLIs and face-to face interactions due to their close relation to students' learning attitude to CMLIS. However, this was not the main focus of the
research and the study does not claim in anyway that it is an explicit or in depth comparison between them.

It is also important to mention here that this study only investigated learners’ attitudes towards CMLIs in relation to LSs and did not investigate lecturers or tutors’ different teaching styles. However, it is recognized that an investigation of lecturers or designers’ different teaching or design styles may be useful to investigate teachers’ perceptions of learning technologies to provide a more comprehensive picture, as it is likely that these would impact on students’ perceptions and, consequently on the success of the integration of learning technologies into classrooms. The research outlined in this study suggests that it would be useful to further explore of the relationship between LSs and design decisions made for ILSs, and consequently to work towards a more guided approach to ILSs design. Through further examinations of different variables of students' differences and learning preferences we may be able to derive more comprehensive frameworks for more interactive learning systems in terms of its adaptability and adaptivity and get closer to more accurately designing and evaluating ILSs through determining a closer count of the ratio and balance between different types of interactions required based on actual students’ learning profile and course skills to be developed including the 3-CMLIs whether asynchronous, synchronous, student-led, or tutor-led.

Finally, on reflection on the general outcome of the study, it helped in exploring and finding out more about students' attitude towards CMLIs focusing on LSs and CMLIs, supported theory from literature, added new dimensions, and proposed a design model and guidelines for interactive learning systems. However, reflecting on its strengths and weaknesses, I would like to recommend some improvements to the nature of the second phase, in terms of replacing its two settings with a longitudinal study of the same population of the first phase and include interviews, in addition to the questionnaires, to further investigate learning preferences in terms of the aspect of technology mediated and non-mediated interactions, to strengthen the research contribution and rigour. Furthermore, looking at the research results, I would recommend the use of one dimension of LSs (for example Active-Reflective or Visual-Verbal) rather than two of them, due to the overlapping nature of different dimensions of the Index of LSs as well as to narrow down its focus on the chosen dimension to strengthen the results. Last but not least, I recommend linking the LSs to one or more factors (such as prior knowledge, gender, English language proficiency) due to their possible influence on LSs themselves, and add more statistical modelling and tests to further strengthen its detailed analysis of multi variant relationships of factors investigated.
7.5 Summary and concluding comments

While recognizing that the small-scale study is unlikely to provide conclusive data or comprehensive evidence to challenge old theory or add new theory on student learning and ILSs design, it nonetheless provides some insights that help in better understanding such complex issues related to the planning and design of ILSs, which in turn may be further explored. Given the primacy of 'Interactive Learning', the motivation for this research was a better understanding of students' different learning preferences and perceptions of CMLIs, as this may offer some insights into how interactivity can be planned and incorporated more purposefully into learning systems designs. The study has provided evidence to support the differing views of learners of different styles at different stages of their learning, in different learning environments, and with different computing background. It has found statistical significant evidence for an association between AR and high/low use of both S-I and S-S, and has also indicated that knowledge of LSs should not be treated in isolation from other students' individual differences.

This study has looked at ILSs from the LSs perspective. While there is no single one correct perspective, there are several considerations that should be taken into account. ILSs design is about establishing relevance and appropriateness for given learners and learning situations and aligning instructional designs accordingly. An adaptive and adaptable approach that offers opportunities to cater for target learners is essential. The ultimate aim for educational research in the area of CML is to optimise instructional designs so as to maximise learning opportunities. For learning systems to be interactive for the learner it is important to engage the learner in the learning process. This will require raising designers' and teachers' awareness of learners' differences and to call upon them to take necessary steps to consider actual learners' LSs and individual differences in course design. The study contributes to the body of knowledge about students learning differences and their relation to different aspects of interactivities of course design that could help the planning and design of a more adaptive and adaptable learning systems that are more relevant and related to students' differences. This may in turn help to improve students' attitude towards the use of such systems for learning and the way they are perceived. The outcomes from the research described offer practical examples of students' use and perceptions of CMLIs and give some insight into a complex array of processes that constitute the dynamics of ILSs.
This study identified ten implications of the findings on the ILS design to support its adaptation and interactivity, which may contribute to establishing research-based principles, design model and framework to guide the planning and design of ILSs that are based on three fundamental considerations. One, the actual LSs exhibited by learners in question. Two, the skills that need to be developed by the target learners. Three, the importance of considering LSs with other ILS components and as a subcomponent of its 'Learner' component. It is not argued here that using LSs instruments give absolute or definite answers to all learners' problems in using ILSs, but instead they help to highlight and predict some areas of possible significance to learners' learning in order to take necessary avoidance action and if necessary remedial action before it is too late. It is also argued that knowledge of LSs should not be treated in isolation from other students' differences, and that knowledge of other individual differences such as prior knowledge may have a direct influence on students' learning preferences and possibly on LSs. The field of ILSs is a rich seam for teachers and/or designers' interpretation and imagination. However, its future lies in how it is utilized. From the users' perspective it is about adaptability, adaptivity, and flexibility rather than an ad hoc learning methods or approaches that do not relate closely to their varying learning preferences, strengths, or weaknesses.
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Appendices

Appendix 1

Index of Learning Styles Questionnaire
(Felder and Soloman, 1999)

Survey of Learning Preferences- Autumn semester 2001/2002

Research is being carried out to investigate undergraduate students' learning styles and their perception of various features of Interactive Web/Computer-based technologies for supporting their learning. And in order to do that, it is important to have an accurate understanding of learners' experiences and preferences. This is why we are asking you to help us by completing this questionnaire in order to find out what you think about certain features of the Web as a tool for interactive learning. The information you provide on this form will be treated as confidential and will not be attributed to you as an individual in any research. No information about individuals will be passed on to anyone else in or out of the department, and will not include names in any research reports or article we write. You are not required to put in your name, unless you would like to participate in future interviews/ research, to which we would very much appreciate it. Expected completion time between 15-20 minutes. Thank you for your help.

Section 1 Your Learning Style/s
Each of the following questions (1-46) has two answers. Please choose only one answer for each question. If both seem to apply to you, choose the one that applies more frequently. It is important to know that there are no right or wrong answers; simply mark the answer to indicate your choice.

1. I understand something better after I
   try it out.
   think it through.

2. I would rather be considered
   realistic.
   innovative.

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

4. I tend to
   understand details of a subject but may be fuzzy about its overall structure.
   understand the overall structure but may be fuzzy about details
5. When I am learning something new, it helps me to
   - talk about it.
   - think about it.

6. If I were a teacher, I would rather teach a course
   - that deals with facts and real life situations.
   - that deals with ideas and theories.

7. I prefer to get new information in
   - pictures, diagrams, graphs, or maps.
   - written directions or verbal information.

8. Once I understand
   - all the parts, I understand the whole thing.
   - the whole thing, I see how the parts fit.

9. In a study group working on difficult material, I am more likely to
   - jump in and contribute ideas.
   - sit back and listen.

10. I find it easier
    - to learn facts.
    - to learn concepts.

11. In a book with lots of pictures and charts, I am likely to
    - look over the pictures and charts carefully.
    - focus on the written text.

12. When I solve maths problems
    - I usually work my way to the solutions one step at a time.
    - 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
    - I have usually got to know many of the students.
    - I have rarely got to know many of the students.

14. In reading nonfiction, I prefer
    - something that teaches me new facts or tells me how to do something.
    - something that gives me new ideas to think about.

15. I like teachers
    - who put a lot of diagrams on the board.
    - who spend a lot of time explaining.

16. When I'm analysing a story or a novel
    - I think of the incidents and try to put them together to figure out the themes.
    - 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
   - start working on the solution immediately.
   - try to fully understand the problem first.

18. I prefer the idea of
   - certainty.
   - theory.

19. I remember best
   - what I see.
   - what I hear.

20. It is more important to me that an instructor
   - lay out the material in clear sequential steps.
   - give me an overall picture and relate the material to other subjects.

21. I prefer to study
   - in a study group.
   - alone.

22. I am more likely to be considered
   - careful about the details of my work.
   - creative about how to do my work.

23. When I get directions to a new place, I prefer
   - a map.
   - written instructions.

24. I learn
   - at a fairly regular pace. If I study hard, I'll "get it."
   - in fits and starts. I'll be totally confused and then suddenly it all "clicks."

25. I would rather first
   - try things out.
   - think about how I'm going to do it.

26. When I am reading for enjoyment, I like writers to
   - clearly say what they mean.
   - say things in creative, interesting ways.

27. When I see a diagram or sketch in class, I am most likely to remember
   - the picture.
   - what the instructor said about it.

28. When considering a body of information, I am more likely to
   - focus on details and miss the big picture.
   - try to understand the big picture before getting into the details.
29. I more easily remember
- something I have done.
- something I have thought a lot about.

30. When I have to perform a task, I prefer to
- master one way of doing it.
- come up with new ways of doing it.

31. When someone is showing me data, I prefer
- charts or graphs.
- text summarising the results.

32. When writing a paper, I am more likely to
- work on (think about or write) the beginning of the paper and progress forward.
- 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
- have “group brainstorming” where everyone contributes ideas.
- brainstorm individually and then come together as a group to compare ideas.

34. I consider it higher praise to call someone
- sensible.
- imaginative.

35. When I meet people at a party, I am more likely to remember
- what they looked like.
- what they said about themselves.

36. When I am learning a new subject, I prefer to
- stay focused on that subject, learning as much about it as I can.
- try to make connections between that subject and related subjects.

37. I am more likely to be considered
- outgoing.
- reserved.

38. I prefer courses that emphasize
- concrete material (facts, data).
- abstract material (concepts, theories).

39. For entertainment, I would rather
- watch television.
- read a book.

40. Some teachers start their lectures with an outline of what they will cover. Such outlines are:
- Somewhat helpful to me.
- very helpful to me.
41. The idea of doing homework in groups, with one grade for the entire group,
   - appeals to me.
   - does not appeal to me.

42. When I am doing long calculations,
   - I tend to repeat all my steps and check my work carefully.
   - I find checking my work tiresome and have to force myself to do it.

43. I tend to picture places I have been
   - easily and fairly accurately.
   - with difficulty and without much detail.

44. When solving problems in a group, I would be more likely to
   - think of the steps in the solution process.
   - think of possible consequences or applications of the solution in a wide range of areas.

*****
Appendix 2

Scoring Sheet (Felder and Soloman, 1999)

1. Put "1"s in the appropriate spaces in the table below (e.g. if you answered "a" to Question 3, put a "1" in Column "a" by Question 3).

2. Total the columns and write the totals in the indicated spaces.

3. For each of the four scales, subtract the smaller total from the larger one. Write the difference (1 to 11) and the letter (a or b) with the larger total.

For example, if under "ACT/REF" you had 4 "a" and 7 "b" responses, you would write "3b" on the bottom line under that heading (3 = 7 - 4, and the "b" total was the larger of the two.)

<table>
<thead>
<tr>
<th>ACT/REF</th>
<th>SEN/INT</th>
<th>VIS/VRB</th>
<th>SEQ/GLO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q a b Q a b Q a b Q a b</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1</td>
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<td>41</td>
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<td>42</td>
<td>43</td>
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</table>

Total (sum X's in each column)

<table>
<thead>
<tr>
<th>ACT/REF</th>
<th>SEN/INT</th>
<th>VIS/VRB</th>
<th>SEQ/GLO</th>
</tr>
</thead>
<tbody>
<tr>
<td>a b</td>
<td></td>
<td>a b</td>
<td></td>
</tr>
</tbody>
</table>

(Larger - Smaller) + Letter of Larger (see below*)

*Example: If you totaled 3 for a and 8 for b, you would enter 5b.

Explanation of scores

- 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 ACT/REF 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 that 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.
Appendices

Appendix 3

Self reported Questionnaire

First Section - Your use of the Web/Internet for Learning

In this section, we'd like to know something about your preferences of using some interactive features of the Web/Internet for learning. Please choose only one answer, unless otherwise indicated.

<table>
<thead>
<tr>
<th>47. Computers are useful for learning</th>
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<tbody>
<tr>
<td><strong>Yes</strong></td>
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<tr>
<td><strong>No</strong></td>
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</table>

<table>
<thead>
<tr>
<th>48. The Web/Internet helps me with my learning</th>
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<tr>
<td><strong>Yes</strong></td>
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<tr>
<td><strong>No</strong></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>49. If I am given a choice between attending a face-to-face lecture (traditional) or alternatively watching it virtually (on the Web), I will choose the:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traditional lecture</strong></td>
</tr>
<tr>
<td><strong>Virtual lecture</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>50. The term &quot;Interactive&quot; means to me (in terms of Computer/Web based learning): (please tick ALL that apply)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Using variety of visual, audio &amp; textual elements (multimedia)</strong></td>
</tr>
<tr>
<td><strong>Easy navigation</strong></td>
</tr>
<tr>
<td><strong>Questions &amp; Answers</strong></td>
</tr>
<tr>
<td><strong>Instant feedback</strong></td>
</tr>
<tr>
<td><strong>Online Self-Assessment</strong></td>
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<tr>
<td><strong>Animation</strong></td>
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<tr>
<td><strong>Simulation</strong></td>
</tr>
<tr>
<td><strong>Others (please specify): ..........................................................................................................................</strong></td>
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<table>
<thead>
<tr>
<th>51. The things I like most about using the Web/Internet for learning (in relation to traditional learning) are: (Please tick ALL that apply)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flexibility of time</strong></td>
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<tr>
<td><strong>Flexibility of place</strong></td>
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<tr>
<td><strong>Flexibility of pace</strong></td>
</tr>
<tr>
<td><strong>Allowing more interactions with lecturer and peers &amp; research and resource for information</strong></td>
</tr>
<tr>
<td><strong>Saving time (eg travel time)</strong></td>
</tr>
<tr>
<td><strong>Saving money (eg travel cost)</strong></td>
</tr>
<tr>
<td><strong>Organising my learning more effectively</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>52. I only attend lectures because: (Please tick ALL that apply)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I want to understand the topics</strong></td>
</tr>
<tr>
<td><strong>I want to take notes</strong></td>
</tr>
<tr>
<td><strong>I want to get hints about exam/coursework</strong></td>
</tr>
<tr>
<td><strong>I want to meet my peers</strong></td>
</tr>
<tr>
<td><strong>There is nothing else to do</strong></td>
</tr>
</tbody>
</table>

Interactive Learning Systems for HE

K. A. Sabry
53. I find it difficult to sit in front of the computer longer than:

<table>
<thead>
<tr>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 hour at a time</td>
</tr>
<tr>
<td>1 hour at a time</td>
</tr>
<tr>
<td>2 hours or more at a time</td>
</tr>
</tbody>
</table>

Please choose **only one answer** for each of the following questions:

<table>
<thead>
<tr>
<th>Question</th>
<th>Frequently</th>
<th>Regularly</th>
<th>Sometimes</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>54. I use search engines to download/retrieve subject material and research/collect data to help me with my assignment/coursework</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55. I use e-mail to communicate/interact with my lecturer/tutor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56. I use e-mail to communicate/interact with my peers in group work</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>57. I use Internet Relay Chat (Chat) to discuss course aspects with my peers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>58. I use/used Videoconferencing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>59. I use Discussion board/Bulletin Board to discuss group work with my peers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60. I use/used Computer/Web based learning courses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

61. I consider the discussion board useful because it helps in:

<table>
<thead>
<tr>
<th>Reason</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing my understanding of the subject</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sharing knowledge/experience with others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disseminating information</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solving problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (please specify) ..................................................................</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please select **only one answer** for each of the following questions:

<table>
<thead>
<tr>
<th>Question</th>
<th>Agree</th>
<th>Neither agree or disagree</th>
<th>Disagree</th>
<th>Do not know</th>
</tr>
</thead>
<tbody>
<tr>
<td>62. Adding visual elements such as video clips, graphics etc (rather than just text) to modules' web resources will enhance my learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>63. Adding verbal elements to the text such as sound (eg lecturer's voice) to modules' web resources will enhance my learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>64. Adding visual or verbal elements to the text will not enhance my learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65. Adding simulation to modules' web resources will help me understand some aspects of the course</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>66. Adding animation to modules' web resources will help me understand some aspects of the course</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>67. Web-based tutorials (online tutorials) will help me more with my course than traditional face to face tutorials/lectures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>68.</td>
<td>I would like to see more self-assessment quizzes and exercises on the courses web pages</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>69.</td>
<td>I prefer reading from books rather than reading from the computer screen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70.</td>
<td>I prefer learning from books rather than learning from the computer screen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>71.</td>
<td>I prefer reading lecture notes from handouts rather than from computer screen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>72.</td>
<td>I prefer to use a laptop to take notes in lecture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>73.</td>
<td>I do not like learning from computers/web. I prefer to attend face-to-face lectures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>74.</td>
<td>I prefer to have an online virtual lecture rather than a face to face lecture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75.</td>
<td>I only start studying any particular topic after attending its lecture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>76.</td>
<td>I feel lost if I miss any lecture,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77.</td>
<td>I depend very much on myself. Lectures (whether traditional or virtual) do not represent an important part of my study.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>78.</td>
<td>I prefer to ask the lecturer questions face to face rather than using e-mail</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>79.</td>
<td>If I have a problem understanding a topic, I tend to e-mail the lecturer/tutor rather than seeing him/her face to face</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80.</td>
<td>I feel embarrassed to ask questions during lectures/tutorials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>81.</td>
<td>I would like to see the modules I am studying taught mainly through the web and complemented by face-to-face lectures/tutorials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>82.</td>
<td>I would like to see the modules I am studying taught mainly by face-to-face lectures/tutorials and complemented by some web-based learning material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>83.</td>
<td>I would like to see the modules I am studying taught only by face-to-face lectures/tutorials with no web-based learning material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>84.</td>
<td>I would like to see the modules I am studying taught only by web-based learning material with no face-to-face lectures/tutorials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>85.</td>
<td>Using search engines to research/collect data is very helpful for my assignment/coursework</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>86.</td>
<td>Using e-mail to communicate with my lecturer/tutor is important</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>87.</td>
<td>Using e-mail to communicate with my peers in group work is important</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>88.</td>
<td>Using Internet Relay Chat (Chat) to discuss course aspects with my peers is useful</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>89.</td>
<td>Using Videoconferencing is useful</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90.</td>
<td>Using Discussion board/Bulletin Board online forums to discuss course aspects with my peers is useful</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
91. Using Computer based learning/web based learning courses is useful

92. I prefer downloading lecture slides/notes rather than taking notes in lecture

93. I consider the live chat useful because it helps in:

- Developing my understanding of the subject
- Sharing knowledge/experience with others
- Disseminating information
- Solving problems
- Others (please specify) .................................................................

Second Section - Your Background

In this section, we'd like to know something about your preferences of using some interactive features of the Web/Internet for learning. Please tick all that applies.

94. I describe generally my computer background as:

- Excellent
- Good
- Reasonable
- Beginner

95. I describe generally my Internet/Web background as:

- Excellent
- Good
- Reasonable
- Beginner

96. Before joining Brunel I had computer experience for: (please complete)

............................................................................................................................. Years.

97. The qualifications I had when I started this course are: (please complete)

- GCE 'A' level or equivalent (subjects: .................................................................)
- GCSE or equivalent (subjects: .................................................................)
- Degree or higher: .................................................................
- Other qualifications: .................................................................

98. I consider my main background is in the area of:

- Computing
- Art
- Maths
- Science
- Business
- Others (please specify)
99. I prefer to study in the: (please tick all that apply):

<table>
<thead>
<tr>
<th>Morning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afternoon</td>
</tr>
<tr>
<td>Evening</td>
</tr>
<tr>
<td>Night</td>
</tr>
</tbody>
</table>

Third Section- About you
In this section, we'd like to know some basic information about you. Which of these is true of you? Please choose only one answer for each question unless otherwise indicated.

100. I'm in my

<table>
<thead>
<tr>
<th>First year of study (Level One).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second year of study (Level Two).</td>
</tr>
<tr>
<td>Third year of study (Level Three).</td>
</tr>
<tr>
<td>Others: (please specify)</td>
</tr>
</tbody>
</table>

101. I am

<table>
<thead>
<tr>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
</tr>
</tbody>
</table>

102. I am

<table>
<thead>
<tr>
<th>18-20 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-25 years old</td>
</tr>
<tr>
<td>26-30 years old</td>
</tr>
<tr>
<td>31 years old and over</td>
</tr>
</tbody>
</table>

103. My native language (mother tongue) is:

<table>
<thead>
<tr>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Others: (please specify)</td>
</tr>
</tbody>
</table>

104. My native language isn't English. I consider myself: (please tick all that apply)

<table>
<thead>
<tr>
<th>Fluency</th>
<th>In Spoken English</th>
<th>In Written English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

105. I am considered disabled

<table>
<thead>
<tr>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

106. During my study, I work part time

<table>
<thead>
<tr>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
</tr>
</tbody>
</table>
107. My Country of Origin is: (Please complete)

..............................................................

108. The course that I'm doing here at Brunel is

| Information Systems                   |
| Computer science                      |
| Others (please specify):              |

ANY ADDITIONAL COMMENTS (If you have any additional comments please state them here)

Important Notice:

We may want to follow up this discussion/questionnaire later in the year as part of the same research project. Would you be willing to take part? If yes, please leave your name & e-mail below.

Name: ........................................ E-Mail: ..............................................................................................

Thank you for your help

If you would like to receive feedback about your learning style, then please leave your name and e-mail below.

Name: ........................................ E-Mail: ..............................................................................................

Thank you very much for helping us in our research; your views will contribute towards a better understanding of learners, and of their learning preferences.
## Appendix 4

### Index of Learning Styles Questionnaire/ Vis-Vrb & Learning Preferences questionnaire

**Survey of Learning Preferences - Autumn semester 2002/2003**

Research is being carried out to investigate Postgraduate students' learning styles and their perception of various features of MS Access DBMS, particularly SQL and QBE features. Expected completion time between 5-10 minutes. Thank you for your help. Please tick **Only One answer for each question, unless otherwise indicated**. If both answers seem to apply to you, choose the one that applies more frequently. It is important to know that there are no right or wrong answers; simply mark the answer to indicate your choice. **You are not required to put in your name.**

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When I think about what I did yesterday, I am most likely to get</td>
<td>a picture.</td>
</tr>
<tr>
<td>2. I prefer to get new information in</td>
<td>pictures, diagrams, graphs, or maps.</td>
</tr>
<tr>
<td>3. In a book with lots of pictures and charts, I am likely to</td>
<td>look over the pictures and charts carefully.</td>
</tr>
<tr>
<td>4. I like teachers</td>
<td>who put a lot of diagrams on the board.</td>
</tr>
<tr>
<td>5. I remember best</td>
<td>what I see.</td>
</tr>
<tr>
<td>6. When I get directions to a new place, I prefer</td>
<td>a map.</td>
</tr>
<tr>
<td>7. When I see a diagram or sketch in class, I am most likely to remember</td>
<td>the picture.</td>
</tr>
<tr>
<td>8. When someone is showing me data, I prefer</td>
<td>charts or graphs.</td>
</tr>
<tr>
<td>9. When I meet people at a party, I am more likely to remember</td>
<td>what they looked like.</td>
</tr>
<tr>
<td>10. For entertainment, I would rather</td>
<td>watch television.</td>
</tr>
<tr>
<td>11. I tend to picture places I have been</td>
<td>easily and fairly accurately.</td>
</tr>
<tr>
<td>12. I am</td>
<td>Male</td>
</tr>
</tbody>
</table>

---

Interactive Learning Systems for HE  
K. A. Sabry
13. I describe generally my background (before starting this Module) in each of the following areas as:
(Please tick only one answer for each of the four areas)

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Good</th>
<th>Beginner</th>
<th>Database</th>
<th>SQL</th>
<th>QBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Computing (eg Word processing, spreadsheet, etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14. My First language is:

- English
- Not English

15. Please tick ALL that apply:

- SQL is difficult to learn
- QBE is difficult to learn

16. I found it easier to learn:

- SQL
- QBE

17. If I have a choice between using SQL and QBE in real life, I will choose:

- SQL
- QBE

18. When using SQL and do something wrong, the feedback I get to correct it is helpful

- Yes
- No

19. When using QBE and do something wrong, the feedback I get to correct it is helpful

- Yes
- No

20. The material I use to help me learn SQL and QBE is:

- Only the Lab Sessions notes
- The Lab sessions notes and other resources (eg books, etc.)

21. The course that I'm doing here at Brunel is:

- Information Systems
- Distributed Information Systems
- Others (please specify):

Thank you very much for helping us in our research; you views will contribute towards a better understanding of learners, and of their learning preferences.
Appendix 5

Index of Learning Styles Questionnaire/ Vis-Vrb & Act-Ref & Learning Preferences questionnaire

<table>
<thead>
<tr>
<th>Survey of Learning Preferences- end of spring semester 2002/2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>This research is to find out your perception of the Web, and different levels of interactivities in relation to the Virtual Lecture of the SD module. Thank you for your help. Please tick Only One answer for each question, unless otherwise indicated. If both answers seem to apply to you, choose the one that applies more frequently. It is important to know that there are no right or wrong answers; simply tick the answer to indicate your choice.</td>
</tr>
</tbody>
</table>

1. When I think about what I did yesterday, I am most likely to get
   - a picture.
   - words.

2. I prefer to get new information in
   - pictures, diagrams, graphs, or maps.
   - written directions or verbal information.

3. In a book with lots of pictures and charts, I am likely to
   - look over the pictures and charts carefully.
   - focus on the written text.

4. I like teachers
   - who put a lot of diagrams on the board.
   - who spend a lot of time explaining.

5. I remember best
   - what I see.
   - what I hear.

6. When I get directions to a new place, I prefer
   - a map.
   - written instructions.

7. When I see a diagram or sketch in class, I am most likely to remember
   - the picture.
   - what the instructor said about it.

8. When someone is showing me data, I prefer
   - charts or graphs.
   - text summarising the results.

9. When I meet people at a party, I am more likely to remember
   - what they looked like.
   - what they said about themselves.

10. For entertainment, I would rather
    - watch television.
    - read a book.

11. I tend to picture places I have been
    - easily and fairly accurately.
    - with difficulty and without much detail.

12. I understand something better after I
    - try it out.
    - think it through.

13. When I am learning something new, it helps me to
    - talk about it.
    - think about it.

14. In a study group working on difficult material, I am more likely to
    - jump in and contribute ideas.
    - sit back and listen.

15. In classes I have taken
    - I have usually got to know many of the students.
    - I have rarely got to know many of the students.

16. When I start a homework problem, I am more likely to
    - start working on the solution immediately.
    - try to fully understand the problem first.
<table>
<thead>
<tr>
<th>Question</th>
<th>Response Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. I prefer to study</td>
<td>in a study group. alone.</td>
</tr>
<tr>
<td>18. I would rather first</td>
<td>try things out. think about how I'm going to do it.</td>
</tr>
<tr>
<td>19. I more easily remember</td>
<td>something I have done. something I have thought a lot about.</td>
</tr>
<tr>
<td>20. When I have to work on a group project, I first want to</td>
<td>have &quot;group brainstorming&quot; where everyone contributes ideas. Brainstorm individually and then come together as a group to compare ideas.</td>
</tr>
<tr>
<td>21. I am more likely to be considered</td>
<td>outgoing. reserved.</td>
</tr>
<tr>
<td>22. The idea of doing homework in groups, with one grade for the entire group</td>
<td>appeals to me. does not appeal to me.</td>
</tr>
<tr>
<td>23. The web is useful for my learning because it makes it easier to communicate with my peers</td>
<td>agree. neither agree or disagree. disagree</td>
</tr>
<tr>
<td>24. The web is useful for my learning because it makes it easier to communicate with my tutors/lecturers</td>
<td>agree. neither agree or disagree. disagree</td>
</tr>
<tr>
<td>25. The web is useful for my learning because it makes it easier to search for information and read/download course related material</td>
<td>agree. neither agree or disagree. disagree</td>
</tr>
<tr>
<td>26. In terms of preference, the thing I like most about using the web for learning is (please tick Only One):</td>
<td>searching for information and reading/downloading course related material. communicating with my tutors/lecturers. communicating with my peers. Others (specify) ........................................</td>
</tr>
<tr>
<td>27. I rate the Interactivity level of the SD Virtual Lecture as:</td>
<td>high. medium. low. not interactive.</td>
</tr>
<tr>
<td>28. The SD Virtual Lecture could be more Interactive for me if it incorporates the following features (please specify):</td>
<td>............................................................................</td>
</tr>
<tr>
<td>29. I rate the Interactivity level of the SD module (as a whole) as:</td>
<td>high. medium. low. not interactive.</td>
</tr>
<tr>
<td>30. The SD module could be more interactive for me if it incorporates more (please tick Only One):</td>
<td>interactions with my peers through the discussion board. interactions with my tutor through the discussion board. self-assessment questions in the Virtual lecture. Others (please specify) ........................................</td>
</tr>
<tr>
<td>31. I use the web to read &amp; download course material or to search websites for information relevant to my course:</td>
<td>0-1 times a week. 2-5 times a week. More than 5 times a week</td>
</tr>
<tr>
<td>32. I use e-mail to discuss with my peers issues related to the course or group work:</td>
<td>0-1 times a week. 2-5 times a week. More than 5 times a week</td>
</tr>
</tbody>
</table>
33. I use e-mail to communicate with my tutors/lecturers:

| 0-1 times a week | 2-5 times a week | More than 5 times a week |

34. If I have the choice between learning from a book or through a computer, I will choose:

| the book | the computer |

35. If I have the choice between communicating with my peers by e-mail or face-to-face, I will choose:

| e-mail | face-to-face |

36. If I have the choice between communicating with my tutor/lecturer by e-mail or face-to-face, I will choose:

| e-mail | face-to-face |

37. If I have the choice between attending a lecture face-to-face or watching it as Virtual Lecture on the web/online, I will choose:

| the web | face-to-face |

38. If I have the choice between going to library or searching the web for information, I will choose:

| the library | the web |

39. The video clip at the beginning of each topic of the Virtual Lecture (to introduce the topic) is a good idea:

| agree | neither agree or disagree | disagree |

40. Adding more of these video clips to other parts of the Virtual Lecture will improve its interactivity:

| agree | neither agree or disagree | disagree |

41. I am

| Male | Female |

42. My first language is:

| English | not English |

43. I am

| 21 years old or under | 22-25 years old | over 25 years old |

44. I describe generally my computer background (before starting this SD Module) in each of the following areas as:

<table>
<thead>
<tr>
<th>Word processing</th>
<th>Spreadsheet</th>
<th>The Internet</th>
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<tr>
<td>Good</td>
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</tbody>
</table>

I may want to follow up this questionnaire later on as part of the same research. Would you be willing to take part? If yes, please leave your name and e-mail below.

Name: ........................................ Brunel e-mail: ..........................................................

Thank you very much for your help. The information you provide on this form will be treated as confidential and will not be attributed to you as an individual in any research. No information about individuals will be passed on to anyone else in or out of the department, and will not include names in any research reports or article we write.
Appendix 6

Phase One - initial Results of Population Composition

Level One (L1) population gender comparison
Level Two (L2) population gender comparison
Appendices

Master Level (ML) population gender comparison
Appendix 7
Phase Two–First Setting

Population of first setting

Comparison between IS & DS Students background before starting the module
Appendix 8

Figures

Figure A4.1 Mean percentage comparison between the 3 levels

Figure A4.2 Breakdown comparisons between the 3 levels

Figure A4.3 Mean percentage comparison between the 3 levels
Figure A4.4 Breakdown comparisons between the 3 levels

Figure A4.5 Strength levels comparison between the 3 levels in terms of perception of S-I interaction (VV)

Figure A4.6 L1 comparison between the 3 interactions
Interactive Learning Systems for HE

Figure A4.10 L2 comparison between the 3 interactions

Figure A4.11 ML comparison between the 3 interactions

Figure A4.12 L1 comparison between the 3 interactions
Figure A4.14 ML comparison between the 3 interactions

Figure A4.15 L1 comparison between the 3 interactions
Appendices

Figure A4.16 L2 comparison between the 3 interactions

Figure A4.17 ML comparison between the 3 interactions

Figure A4.18 L1 comparison between the styles
Figure A4.19 L2 comparison between the styles.

Figure A4.20 ML Comparison between the styles.

Figure A4.21 LI Comparison between the styles.
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Figure A4.25 Comparison between the three levels in terms of agreeing with the statement

Figure A4.26 Comparison between the styles

Figure A4.27 Comparison between the levels and styles
Appendices

Figure A4.28 Comparison between the levels and styles

Figure A4.29 Comparison between the levels and styles

Figure A4.30 Comparison between the levels and styles

Visual Verbal String/Mod-Vis String/Mod-Vrb
L1 40.51% 37.50% 29.11% 0.00%
L2 22.50% 18.18% 10.00% 0.00%
ML 29.03% 20.00% 9.68% 10.00%

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Figure A4.31 Comparison between the levels and styles

Figure A4.32 Comparison between the styles

Figure A4.33 Comparison between the levels and styles
Appendices

Figure A4.34 Comparison between the styles

Figure A4.35 Comparison between the levels and styles

Figure A4.36 Comparison between the styles
Figure A4.37 Comparison between the levels and styles
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Mild LS  Stronger LS

Table A4.1 L1 students' use of S-I interaction (VV)

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Mild LS  Stronger LS

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Mild LS  Strong LS

Table A4.3 ML students' use of S-I interaction (VV)

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Mild LS  Strong LS

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Table A4.5 ML students' use of S-I interaction (AR)

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<th>Perception %</th>
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Table A4.8 Relation between 3 levels in terms of S-T interaction

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Table A4.7 Comparison between the styles in terms of perception of S-I interaction
### Table A4.10 L2 students' use of S-T interaction (VV)

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<td>Visual</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Low use</td>
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</tr>
<tr>
<td>Visual</td>
<td></td>
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<tr>
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### Table A4.12 ML students S-T interaction (VV)

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</tr>
<tr>
<td>Active</td>
<td>High</td>
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<td>Overall</td>
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<td>----------</td>
<td></td>
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<tr>
<td>Act-mild</td>
<td>28.13%</td>
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<tr>
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Table A4.15 L2 students S-T interaction

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Overall Strong LS

Table A4.16 ML students’ use of S-T interaction (AR)

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Table A4.17 ML students S-T interaction

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<th>agree-disagree</th>
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<td>50.63%</td>
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<td>18.75%</td>
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<td>0.00%</td>
<td>18.75%</td>
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<td>6.33%</td>
<td>1.27%</td>
<td>2.53%</td>
<td>15.19%</td>
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<tr>
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Table A4.18 L1 students S-T interaction (VV)

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<th>agree-disagree</th>
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<td>5.00%</td>
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<td>27.27%</td>
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<td>0.00%</td>
<td>0.00%</td>
<td>45.00%</td>
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<td>0.00%</td>
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Table A4.19 L2 students S-T interaction (VV)

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<td>80.00%</td>
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<tr>
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<td>48.39%</td>
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<tr>
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<td>20.00%</td>
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<tr>
<td>VRB-MILD</td>
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Table A4.20 ML students S-T interaction (VV)

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### Table A4.21 L1 students S-T interaction (AR)

<table>
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### Table A4.23 ML students S-T interaction (AR)

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<th>disagree</th>
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### Table A4.24 comparison between the styles in terms of perception of S-T Interaction

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<tr>
<td>Visual</td>
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<td>62.2</td>
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### Table A4.25 comparison between the 3 levels' perception of S-T interaction

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<th>L2</th>
<th>ML</th>
</tr>
</thead>
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<td>80.00%</td>
<td>61.29%</td>
</tr>
<tr>
<td>verb</td>
<td>62.50%</td>
<td>45.45%</td>
<td>80.00%</td>
</tr>
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<td>VIS-MLD</td>
<td>16.46%</td>
<td>35%</td>
<td>12.90%</td>
</tr>
<tr>
<td>VRB-MLD</td>
<td>43.75%</td>
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<td>60%</td>
</tr>
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<td>45.00%</td>
<td>48.39%</td>
</tr>
<tr>
<td>String/Mod-verb</td>
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<td>9.09%</td>
<td>20.00%</td>
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### Table A4.26: Comparison between the 3 levels’ perception of S-T interaction

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<th>ML</th>
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<td>71.66%</td>
<td>57.69%</td>
</tr>
<tr>
<td>Ref</td>
<td>58.82%</td>
<td>73.68%</td>
<td>80%</td>
</tr>
<tr>
<td>Mild-act</td>
<td>34.43%</td>
<td>56.25%</td>
<td>19.23%</td>
</tr>
<tr>
<td>Mild-ref</td>
<td>52.94%</td>
<td>42.11%</td>
<td>66.67%</td>
</tr>
<tr>
<td>Stmg/Mod-act</td>
<td>36.07%</td>
<td>15.63%</td>
<td>38.46%</td>
</tr>
<tr>
<td>Stmg/Mod-ref</td>
<td>5.88%</td>
<td>31.58%</td>
<td>13.33%</td>
</tr>
</tbody>
</table>

### Table A4.27: LI Learning styles and the use of S-S interaction (VV)

<table>
<thead>
<tr>
<th>LS</th>
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</tr>
</thead>
<tbody>
<tr>
<td>vis</td>
<td>50.65%</td>
</tr>
<tr>
<td>vrb</td>
<td>43.75%</td>
</tr>
<tr>
<td>Stmg/Mod-vis</td>
<td>41.56%</td>
</tr>
<tr>
<td>Stmg/Mod-vrb</td>
<td>18.75%</td>
</tr>
<tr>
<td>VIS-MILD</td>
<td>9.09%</td>
</tr>
<tr>
<td>VRB-MILD</td>
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</tr>
</tbody>
</table>

### Table A4.28: L2 Learning styles and the use of S-S interaction (VV)

<table>
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</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>vrb</td>
<td>63.64%</td>
</tr>
<tr>
<td>Stmg/Mod-vis</td>
<td>39.02%</td>
</tr>
<tr>
<td>Stmg/Mod-vrb</td>
<td>18.18%</td>
</tr>
<tr>
<td>VIS-MILD</td>
<td>17.07%</td>
</tr>
<tr>
<td>VRB-MILD</td>
<td>45.45%</td>
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</table>

### Table A4.29: ML Learning styles and the use of S-S interaction (VV)

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
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</tr>
<tr>
<td>Reflective</td>
<td>28.47%</td>
</tr>
<tr>
<td>Stmg/Mod-Act</td>
<td>37.29%</td>
</tr>
<tr>
<td>Stmg/Mod-Ref</td>
<td>8.62%</td>
</tr>
<tr>
<td>Mid-Act</td>
<td>25.42%</td>
</tr>
<tr>
<td>Mid-Ref</td>
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</tr>
</tbody>
</table>

### Table A4.30: LI Learning styles and the use of S-S interaction (AR)

<table>
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<tr>
<th>LS</th>
<th>Freq/Reg</th>
</tr>
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<tbody>
<tr>
<td>Interactive</td>
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</tr>
<tr>
<td>Reflective</td>
<td>28.47%</td>
</tr>
<tr>
<td>Stmg/Mod-Act</td>
<td>37.29%</td>
</tr>
<tr>
<td>Stmg/Mod-Ref</td>
<td>8.62%</td>
</tr>
<tr>
<td>Mid-Act</td>
<td>25.42%</td>
</tr>
<tr>
<td>Mid-Ref</td>
<td>17.65%</td>
</tr>
</tbody>
</table>
### Table A4.31 L2 Learning styles and the use of S-S interaction (AR)

<table>
<thead>
<tr>
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<th>Freq/Reg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>65.63%</td>
</tr>
<tr>
<td>Reflective</td>
<td>45.00%</td>
</tr>
<tr>
<td>String/Mod-Act</td>
<td>18.75%</td>
</tr>
<tr>
<td>String/Mod-Ref</td>
<td>15.00%</td>
</tr>
<tr>
<td>Mid-Act</td>
<td>46.68%</td>
</tr>
<tr>
<td>Mid-Ref</td>
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</tr>
</tbody>
</table>

### Table A4.32 ML Learning styles and the use of S-S interaction (AR)

<table>
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<tr>
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<th>disagree</th>
<th>don't know</th>
<th>agree-disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>vis</td>
<td>75.95%</td>
<td>17.72%</td>
<td>3.80%</td>
<td>2.53%</td>
<td>72.15%</td>
</tr>
<tr>
<td>vr 6</td>
<td>68.75%</td>
<td>25.00%</td>
<td>0.00%</td>
<td>6.25%</td>
<td>68.75%</td>
</tr>
<tr>
<td>String/Mod-vis</td>
<td>56.23%</td>
<td>2.53%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>58.23%</td>
</tr>
<tr>
<td>String/Mod-vr</td>
<td>25.00%</td>
<td>12.50%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>25.00%</td>
</tr>
<tr>
<td>VIS-MILD</td>
<td>17.72%</td>
<td>6.33%</td>
<td>0.00%</td>
<td>2.53%</td>
<td>17.72%</td>
</tr>
<tr>
<td>VRB-MILD</td>
<td>43.75%</td>
<td>12.50%</td>
<td>0.00%</td>
<td>6.25%</td>
<td>43.75%</td>
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</table>

### Table A4.33 L1 Learning styles and their perception of S-S interaction

<table>
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<th>neither agree or disagree</th>
<th>disagree</th>
<th>don't know</th>
<th>agree-disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>vis</td>
<td>75.00%</td>
<td>17.50%</td>
<td>5.00%</td>
<td>2.50%</td>
<td>70.00%</td>
</tr>
<tr>
<td>vr 6</td>
<td>54.55%</td>
<td>18.18%</td>
<td>27.27%</td>
<td>0.00%</td>
<td>27.27%</td>
</tr>
<tr>
<td>String/Mod-vis</td>
<td>45.00%</td>
<td>5.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>45.00%</td>
</tr>
<tr>
<td>String/Mod-vr</td>
<td>9.09%</td>
<td>0.00%</td>
<td>18.18%</td>
<td>0.00%</td>
<td>-9.09%</td>
</tr>
<tr>
<td>VIS-MILD</td>
<td>30.00%</td>
<td>12.50%</td>
<td>2.50%</td>
<td>0.00%</td>
<td>27.50%</td>
</tr>
<tr>
<td>VRB-MILD</td>
<td>45.45%</td>
<td>18.18%</td>
<td>9.09%</td>
<td>0.00%</td>
<td>36.36%</td>
</tr>
</tbody>
</table>

### Table A4.34 L2 Learning styles and their perception of S-S interaction

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<th>don't know</th>
<th>agree-disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>vis</td>
<td>74.18%</td>
<td>12.90%</td>
<td>12.90%</td>
<td>0.00%</td>
<td>61.29%</td>
</tr>
<tr>
<td>vr 6</td>
<td>90.00%</td>
<td>10.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>90.00%</td>
</tr>
<tr>
<td>String/Mod-vis</td>
<td>51.61%</td>
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<td>0.00%</td>
<td>51.61%</td>
</tr>
<tr>
<td>String/Mod-vr</td>
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<td>10.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>20.00%</td>
</tr>
<tr>
<td>VIS-MILD</td>
<td>22.58%</td>
<td>3.23%</td>
<td>9.68%</td>
<td>0.00%</td>
<td>12.90%</td>
</tr>
<tr>
<td>VRB-MILD</td>
<td>70.00%</td>
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<td>0.00%</td>
<td>0.00%</td>
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</tr>
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</table>

### Table A4.35 ML Learning styles and their perception of S-S interaction
### Table A4.36 L1 Learning styles and their perception of S-S interaction

<table>
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<th>don't know</th>
<th>agree-disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>75.41%</td>
<td>18.03%</td>
<td>4.92%</td>
<td>1.64%</td>
<td>70.49%</td>
</tr>
<tr>
<td>Reflective</td>
<td>73.53%</td>
<td>20.59%</td>
<td>0.00%</td>
<td>5.88%</td>
<td>73.53%</td>
</tr>
<tr>
<td>String/Mod-Act</td>
<td>37.70%</td>
<td>6.56%</td>
<td>1.64%</td>
<td>0.00%</td>
<td>36.07%</td>
</tr>
<tr>
<td>String/Mod-Ref</td>
<td>17.65%</td>
<td>8.92%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>17.65%</td>
</tr>
<tr>
<td>Mid-Act</td>
<td>37.70%</td>
<td>11.48%</td>
<td>3.28%</td>
<td>1.64%</td>
<td>34.43%</td>
</tr>
<tr>
<td>Mid-Ref</td>
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</tbody>
</table>

### Table A4.37 L2 Learning styles and their perception of S-S interaction

<table>
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<th>disagree</th>
<th>don't know</th>
<th>agree-disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>71.88%</td>
<td>15.63%</td>
<td>9.38%</td>
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<td>62.50%</td>
</tr>
<tr>
<td>Reflective</td>
<td>68.42%</td>
<td>21.05%</td>
<td>10.53%</td>
<td>0.00%</td>
<td>57.89%</td>
</tr>
<tr>
<td>String/Mod-Act</td>
<td>18.75%</td>
<td>0.00%</td>
<td>6.25%</td>
<td>0.00%</td>
<td>12.50%</td>
</tr>
<tr>
<td>String/Mod-Ref</td>
<td>31.58%</td>
<td>10.53%</td>
<td>10.53%</td>
<td>0.00%</td>
<td>21.05%</td>
</tr>
<tr>
<td>Mid-Act</td>
<td>53.13%</td>
<td>15.63%</td>
<td>3.13%</td>
<td>3.13%</td>
<td>50.00%</td>
</tr>
<tr>
<td>Mid-Ref</td>
<td>36.84%</td>
<td>10.53%</td>
<td>0.00%</td>
<td>0.00%</td>
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</table>

### Table A4.38 ML Learning styles and their perception of S-S interaction

<table>
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<th>disagree</th>
<th>don't know</th>
<th>agree-disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>76.92%</td>
<td>15.98%</td>
<td>7.69%</td>
<td>0.00%</td>
<td>69.23%</td>
</tr>
<tr>
<td>Reflective</td>
<td>80.00%</td>
<td>6.67%</td>
<td>13.33%</td>
<td>0.00%</td>
<td>66.67%</td>
</tr>
<tr>
<td>String/Mod-Act</td>
<td>38.46%</td>
<td>7.69%</td>
<td>3.85%</td>
<td>0.00%</td>
<td>34.62%</td>
</tr>
<tr>
<td>String/Mod-Ref</td>
<td>20.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>20.00%</td>
</tr>
<tr>
<td>Mid-Act</td>
<td>38.46%</td>
<td>7.69%</td>
<td>3.85%</td>
<td>0.00%</td>
<td>34.62%</td>
</tr>
<tr>
<td>Mid-Ref</td>
<td>60.00%</td>
<td>6.67%</td>
<td>13.33%</td>
<td>0.00%</td>
<td>46.67%</td>
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</table>

### Table A4.39 Comparison between the levels

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<th>ML</th>
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</thead>
<tbody>
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<td>Active</td>
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<td>3.13%</td>
<td>7.69%</td>
</tr>
<tr>
<td>Reflective</td>
<td>2.94%</td>
<td>0.00%</td>
<td>6.67%</td>
</tr>
<tr>
<td>String/Mod-Act</td>
<td>6.56%</td>
<td>3.13%</td>
<td>0.00%</td>
</tr>
<tr>
<td>String/Mod-Ref</td>
<td>0.00%</td>
<td>0.00%</td>
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</table>

### Table A4.40 Comparison between the styles

<table>
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<th>ML</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>39.34%</td>
<td>21.88%</td>
<td>15.38%</td>
</tr>
<tr>
<td>Reflective</td>
<td>41.18%</td>
<td>21.05%</td>
<td>48.67%</td>
</tr>
<tr>
<td>String/Mod-Act</td>
<td>22.95%</td>
<td>0.00%</td>
<td>3.85%</td>
</tr>
<tr>
<td>String/Mod-Ref</td>
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### Table A4.41 Comparison between the styles

<table>
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<th>ML</th>
</tr>
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<tbody>
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<td>81.25%</td>
<td>84.62%</td>
</tr>
<tr>
<td>Reflective</td>
<td>57.58%</td>
<td>68.42%</td>
<td>80.00%</td>
</tr>
<tr>
<td>Strng/Mod-Act</td>
<td>26.67%</td>
<td>25.00%</td>
<td>46.15%</td>
</tr>
<tr>
<td>Strng/Mod-Ref</td>
<td>24.24%</td>
<td>42.11%</td>
<td>20.00%</td>
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</tbody>
</table>

### Table A4.42 Comparison between the styles

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<th>ML</th>
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<td>15.38%</td>
</tr>
<tr>
<td>Reflective</td>
<td>17.65%</td>
<td>21.05%</td>
<td>26.67%</td>
</tr>
<tr>
<td>Strng/Mod-Act</td>
<td>11.67%</td>
<td>6.25%</td>
<td>3.85%</td>
</tr>
<tr>
<td>Strng/Mod-Ref</td>
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<td>10.53%</td>
<td>6.67%</td>
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</table>

### Table A4.43 Comparison between the styles

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<tbody>
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<td>Active</td>
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<td>46.15%</td>
</tr>
<tr>
<td>Reflective</td>
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<td>57.89%</td>
<td>73.33%</td>
</tr>
<tr>
<td>Strng/Mod-Act</td>
<td>42.62%</td>
<td>12.50%</td>
<td>19.23%</td>
</tr>
<tr>
<td>Strng/Mod-Ref</td>
<td>26.47%</td>
<td>26.32%</td>
<td>6.67%</td>
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</tbody>
</table>
Appendix 9

CHI SQ SIGNIFICANCE TEST

Student-Information Interaction

<table>
<thead>
<tr>
<th>S-I</th>
<th>STRONG-MODERATE</th>
<th>AR</th>
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<tr>
<td></td>
<td>ACT</td>
<td>REF</td>
</tr>
<tr>
<td>HIGH</td>
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<td>12</td>
</tr>
<tr>
<td>LOW</td>
<td>7</td>
<td>10</td>
</tr>
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</table>

49

<table>
<thead>
<tr>
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<th>REF</th>
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</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>LOW</td>
<td>11.73</td>
</tr>
</tbody>
</table>

7.00 10.00

49

(O-E)\^2/SQRD

<table>
<thead>
<tr>
<th>O-E</th>
<th>(O-E)^2/SQRD</th>
<th>SQRD</th>
<th>SQRD/E</th>
<th>X SQD</th>
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<td>4.23</td>
<td>17.91</td>
<td>0.48</td>
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<tr>
<td>4.73</td>
<td>4.23</td>
<td>17.91</td>
<td>1.53</td>
<td>1.53</td>
</tr>
</tbody>
</table>

FOR 1 D.F., AT 5% SIGNIFICANCE LEVEL (TABLE G), CHI IS 3.84. THIS IS LESS THAN CHI CALCULATED (8.1). THIS MEANS THERE IS SIGNIFICANT EVIDENCE FOR AN ASSOCIATION BETWEEN AR AND HIGH/LOW USE OF S-I THE CONVENTIONAL (5%) SIGNIFICANCE LEVEL (OR ALTERNATIVELY, THE PROPORTION OF ACTIVE WITH HIGH USE DIFFER SIGNIFICANTLY FROM THE PROPORTION OF REFLECTIVE WITH HIGH USE). THEREFORE, a relationship exists BETWEEN AR LSs and S-I use.
### Student-Student Interaction

<table>
<thead>
<tr>
<th></th>
<th>S-S</th>
<th>STRONG-</th>
<th>MODERATE</th>
<th>AR</th>
</tr>
</thead>
<tbody>
<tr>
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<td>REF</td>
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<td></td>
<td></td>
</tr>
<tr>
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\[(O-E)^2 \text{ SQRD/}E \times \text{SOD \ (CHI)} \]

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<th>SQRD</th>
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<th>X SQRD (CHI)</th>
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<th>D.F.</th>
<th>P</th>
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<th>YATES' P</th>
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<td>5.33</td>
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<td>28.39</td>
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For 1 D.F., at 5% significance level (Table G), CHI is 3.841. This is less than CHI calculated (9.64). This means there is significant evidence for an association between AR and high/low use of S-I. The conventional (5%) significance level (or alternatively, the proportion of active with high use differ significantly from the proportion of reflective with high use). Therefore, a relationship exists between AR LSs and S-S use.
Student-Tutor Interaction

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\[ \frac{(O-E)^2}{O} \] SQRD SQRD/E | X SQD (CHI) |
\hline
\[ 3.29 \] & \[ 3.29 \] & \[ 2.79 \] & \[ 7.76 \] & \[ 0.57 \] & \[ 1.23 \] & \[ 2.52 \] & \[ 0.0611 \] & \[ >0.05 \] & \[ 3.5 \] & \[ <3.841 \] & \[ 1 \] & \[ 2.52 \] & \[ <3.841 \] & \[ 0.112 \] & \[ >0.05 \] \\
\[ 3.29 \] & \[ 2.79 \] & \[ 7.76 \] & \[ 0.23 \]  \\

For 1 D.F., at 5% significance level (Table G), chi is 3.84. This is more than chi calculated (3.50). This means there is no significant evidence for an association between AR and high/low use of S-T the conventional (5%) significance level (or alternatively, the proportion of active with high use does not differ significantly from the proportion of reflective with high use). Therefore, a relationship does not exist between AR LSs and S-T use.
Appendix 10

Figure A5.1 Comparison between IS and DS students

A5.2 Strength level analysis

A5.3 Comparison between the styles (IS)
Appendices

A5.4 Strength level analysis (IS)

Figure A5.5 Strength level analysis (IS)

Figure A5.6 Comparison between the styles (DS)
Appendices

Figure A5.7 Strength level analysis (DS)

Figure A5.8 Strength level analysis (DS)

Figure A5.9 Strength level analysis
Figure A5.10 Comparison between the styles (IS)

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Figure A5.11 Strength level analysis (IS)

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Figure A5.12 Strength level analysis (IS)

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<tr>
<td>QBE</td>
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Appendices

Figure A5.13 Comparison between the styles (DS)

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Figure A5.14 Strength level analysis (DS)

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<tr>
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Figure A5.15 Strength level analysis (DS)

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Figure A5.16 Comparison between the styles

Figure A5.17 Strength level analysis

Figure A5.18 Strength level analysis

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Figure A5.22 Comparison between the styles

Figure A5.23 Strength level analysis

Figure A5.24 Strength level analysis
Appendices

Influence of level of existing knowledge on learning style

Figure A5.25: influence of existing knowledge

Access to WebCT environment

Figure A5.26: Access to WebCT environment

Access to WebCT environment

Figure A5.27: Access to WebCT environment
Figure A5.28: Access to WebCT environment

Figure A5.29: Access to WebCT environment
Figure A5.30: Access to WebCT environment

Figure A5.31: Articles read
Appendices

Figure A5.32: Access to WebCT environment

Figure A5.33: Contrast between the LSs

Figure A5.34 Contrast between the two styles
Figure A5.35 Contrast between the two styles (strength levels)

Figure A5.36 Contrast between the two styles

Figure A5.37 Contrast between the two styles
Figure 5.38 Contrast between the two styles- strength level analysis

Figure A5.39 Contrast between the two styles- strength level analysis
Figure A5.40 Contrast between the two styles—strength level analysis

Figure A5.41 Contrast between the two styles—strength level analysis
Figure A5.42 Contrast between the two styles - strength level analysis

Figure A5.43 Contrast between the two styles - strength level analysis
Figure A5.44 Contrast between the two styles

Figure A5.45 Contrast between the two styles- strength level analysis
Appendix 11

WebCT Learning Environment Observation

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Total number of accesses: 135

Distribution of Visits for Student: S11

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Interactive Learning Systems for HE
K. A. Sabry
Appendices

Student: S1
First login: February 16, 2003 3:20pm
Total number of accesses: 113

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Student: S2
First login: February 17, 2003 10:47pm
Total number of accesses: 149

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Student: S3
First login: February 12, 2003 11:47am
Total number of accesses: 144

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Interactive Learning Systems for HE  
K. A. Sabry
Student: S4
First login: February 17, 2003 9:30am
Total number of accesses: 114

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Student: S5
First login: February 7, 2003 1:32pm
Total number of accesses: 116

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Student: S6
First login: February 7, 2003 4:19pm
Total number of accesses: 124

**Distribution of Visits for**

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Appendices

Student: S7
First login: February 8, 2003 1:17pm
Total number of accesses: 169

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**Distribution of Visits for Student: S7**

Student: S8
First login: February 16, 2003 2:26pm
Total number of accesses: 123

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Student: S9
First login: February 8, 2003 5:34pm
Total number of accesses: 115

**Distribution of Visits for Student: S9**
## Appendices

**Student: S10**
First login: February 9, 2003 2:27pm  
Total number of accesses: 97

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**Discussions**  
- Articles Read: 51  
- Original Posts: 1

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**Student: S12**
First login: February 9, 2003 8:40pm  
Total number of accesses: 65

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**Discussions**  
- Articles Read: 36  
- Original Posts: 1  
- Follow-up Posts: 2

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**Student: S13**
First login: February 4, 2003 5:26pm  
Total number of accesses: 253

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<td>Organizer Pages</td>
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**Discussions**  
- Articles Read: 83  
- Original Posts: 3

---

Interactive Learning Systems for HE  
K. A. Sabry
Student: S14
First login: February 4, 2003 7:14pm
Total number of accesses: 110

### Distribution of Visits for Student: S14

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### Discussions

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<td>Original Posts</td>
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<tr>
<td>Follow-up Posts</td>
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Student: S15
First login: February 4, 2003 8:27pm
Total number of accesses: 243

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### Discussions

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Student: S16
First login: February 10, 2003 2:02pm
Total number of accesses: 121

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### Discussions

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<tr>
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</tr>
<tr>
<td>Follow-up Posts</td>
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### Appendix 12

<table>
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<tr>
<th>Percentage of LS/ Percentage of SRD</th>
<th>High % Active LS- Low % Reflective LS</th>
<th>High % Reflective LS- Low % Active LS</th>
<th>Equal % Active LS &amp; Reflective LS</th>
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<tbody>
<tr>
<td><strong>High % active- involvement &amp; low % reflection</strong>&lt;br&gt;(must match situation)</td>
<td>This is a 'Must Match' situation—a match between LS &amp; SRD, mainly active, blended with reflective principles. Additionally, need monitoring progress of students of lower percentage learning style.</td>
<td>This is a bit problematic, a mismatch between LS &amp; SRD, careful blended design is required, mainly active blended with reflective principles in addition to monitoring progress of students with opposite LS (particularly reflective).</td>
<td>A slight mismatch between LS &amp; SRD, a blended design is required in addition to monitoring progress of students with opposite learning style (particularly reflective).</td>
</tr>
<tr>
<td><strong>High % reflection &amp; low % active involvement</strong>&lt;br&gt;(must match situation)</td>
<td>This is a 'Must Match' situation—a match between LS &amp; SRD, mainly reflective blended with active principles in addition to monitoring progress of students with opposite learning styles (particularly active).</td>
<td>This is a bit problematic, a mismatch between LS &amp; SRD, careful blended design is required, mainly reflective blended with active principles. Additionally, need monitoring progress of students of lower percentage learning style.</td>
<td>A slight mismatch between LS &amp; SRD, a blended design is required in addition to monitoring progress of students with opposite learning style (particularly active).</td>
</tr>
<tr>
<td><strong>Equal % active involvement &amp; reflection</strong>&lt;br&gt;(must match situation)</td>
<td>A slight mismatch between LS &amp; SRD, a blended design is required in addition to monitoring progress of students with opposite LS (particularly reflective).</td>
<td>A slight mismatch between LS &amp; SRD, a blended design is required in addition to monitoring progress of students with opposite learning style (particularly active).</td>
<td>This is a 'Must Match' situation—a match between LS &amp; SRD, equally blended active with reflective principles. Additionally, need monitoring progress of students of lower percentage learning style.</td>
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Possible considerations and suggestions for matching/mismatching