

INFORMATION SYSTEMS FOR INTERACTIVE LEARNING: DESIGN PERSPECTIVE

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Abstract

This paper aims to present and discuss educational issues and relevant research to universities and colleges in the Arabian Gulf Region. This include cultural, students' learning preferences and the use of information and communication technology. It particularly focuses on interactive learning through the consideration of learning styles. It explores the sequential-global learning styles profile of undergraduate students as part of a continuous research in Information Systems design with a particular focus on the design of Interactive Learning Systems (ILSs). A study to examine the learning style profile of undergraduate students in a cohort of Management Information Systems at a UAE university has been conducted, and a discussion and recommendations on how these findings can be reflected on the design of ILSs are provided.

Keywords: Interactive Learning System, Learning Style, learning Interactions, Instructional Design.

1 INTRODUCTION

Research can make significant improvements to the quality of Information Systems design in general and the instructional design in particular (Prince and Felder, 2007) and as part of the instructional design process, it is essential to highlight and understand the variables associated with effective matching of instructional design to learning styles (Liu and Reed, 1994; Felder and Silverman, 1988). Individual differences have significant effects on learners' behaviour (Riding and Rayner, 1998). These differences include amongst others, gender differences (Ford and Miller, 1996), system experience (Holscherl and Strubel, 2000), prior knowledge and spatial ability (Mayer and Gallini, 1990), occupational experience (Durling *et al*, 1996), culture differences (De Vita 2001; Kolb and Fry 1975), cultural and vocational (Al-Khatib, 2007) and cognitive styles (Durfresne and Turcotte, 1997; Shih and Gamon, 1999). However, individual differences make designing learning systems a complex task that requires flexibility in terms of accommodating a wide range of characteristics (Galitz, 2002; Papanikolaou *et al*, 2006), and for such systems to be interactive, certain qualities and principles need to be applied to different learners' needs (Sabry and Baldwin, 2003). Effective use of Computer Mediated Communication (CMC) can result in an increase, not a decrease, in learning interactions such as student-student and instructor-student interactivity (Lavooy & Newlin, 2003), and technology tools can be used to communicate, scaffold, and clarify course concepts and content while engaging students with information (Solvie and Kloek, 2007). However, much of the learning styles research has not given much attention to influencing factors such as learners' perception of different interaction types on their learning approach, and the consequent effect on the design of ILSs (Sabry and Baldwin, 2003). Further, despite the long-standing research interest in the area of e-learning, unsatisfactory implementation continue to be encountered in practice (Hogarth & Dawson, 2008).

The following sections of this paper describe ILSs and present a study in which the sequential-global learning style dimension (concerned with the progression towards understanding) is explored. The findings are then presented and followed by a discussion of the implications on ILSs design.

2 INTERACTIVE LEARNING SYSTEMS (ILSs)

Based on Hoffer *et al* (1999), a system is *an interrelated set of components, with an identifiable boundary, working together for some purpose*. Information Systems are inter-disciplinary systems that can be described similarly as interrelated information and knowledge components with identifiable boundary, working together for some purpose. An ILS in return can be described as an Information and knowledge system for the purpose of learning and teaching. It is considered as a learning system that incorporates certain design principles and qualities such as the ability to promote active thinking (Salmon, 2002), allow for reflection and provide feedback (Laurillard, 2002), provide relevant interactions, different choices and variety of interaction patterns (Evans & Sabry, 2003). It incorporates multimedia elements for supporting learning, which are generally preferred by many students compared with traditional learning methods (Boon Shiong et al, 2008). It incorporates latest technologies that may contribute to its flexibility, adaptability, adaptivity and mobility. Based on Baldwin and Sabry (2003) and Sabry (2005), ILSs consists of five main knowledge components:

Content: contains and links to information and knowledge sources related to subject area in digital form (eg e-book, virtual lecture, e-libraries, web, etc). It contains tasks to be taught in relation to course aims and objectives, and skills to be developed. This should also contain dictionaries to support student whose English is not their first language.

Learner: contains knowledge and considerations about the student, including individual differences (eg gender, culture, prior knowledge, age, etc.) and preferred learning styles of learning (eg sequential, global, Active, etc.)

Technology: contains knowledge and considerations about the media through which information and knowledge contents can be delivered and multimedia representation to accommodate different types of interactions, teaching and learning styles. This also includes different technologies whether asynchronous and/or synchronous. This component is a dynamic component that seeks up-to-date technologies and use of variety of innovative technologies to accomplish the system's goals and objectives (for example use of latest technologies that assist the flexibility, adaptivity, adaptability and learning interactivity such as iphone, PDA, Wi-Fi, etc.)

Pedagogy: contains pedagogical knowledge, methods and styles of teaching relevant to each subject matter, aims and objectives, and learners' differences. The wider the range of included strategies, the more effective and efficient the teaching and learning will be.

Interaction: this is the component that coordinates and balances the other four components. It includes HCI knowledge for design principles, multimedia presentation considerations and decisions about interactivity level, type of interactions, and teaching styles to be used in accordance to different contents, different learners and technologies used (see Figure 1).

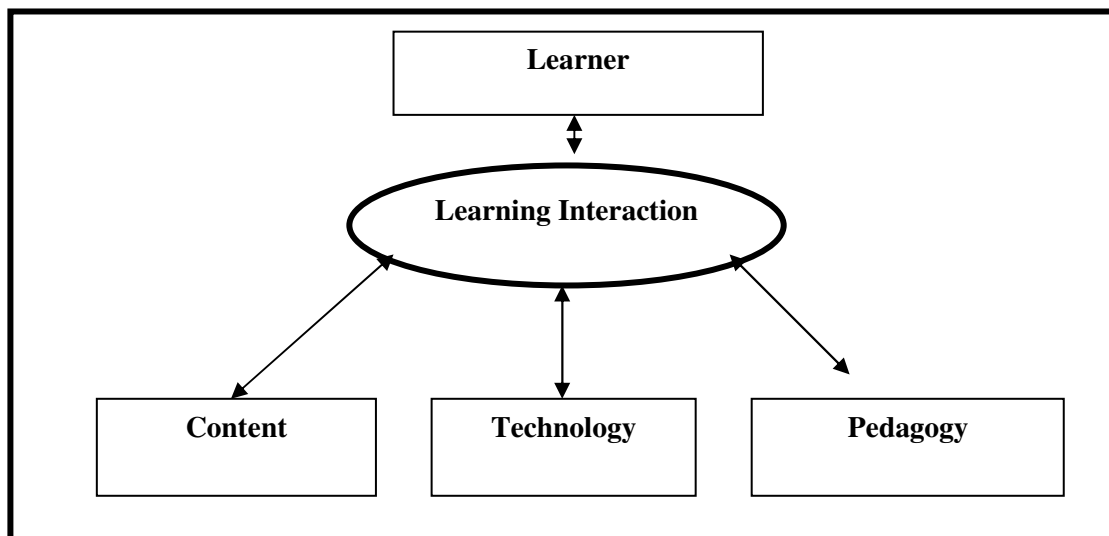


Figure 1. Components of an ILS

An ILS engages the learner with a variety of interactions with materials, peers, and experts (Bonk, 1999). It allows for different types of learning interactions that can be categorised into four types (Moore, 1989; Hillman *et al*, 1994; Moore and Kearsley, 1996): Learner-content, learner-instructor, learner-learner, and learner-interface. These interactions are incorporated through the 'Interaction' component of the ILS. Figure 2 shows the three main types of learning interactions that are the focus of this paper: student-information, student-lecturer, and student-student.

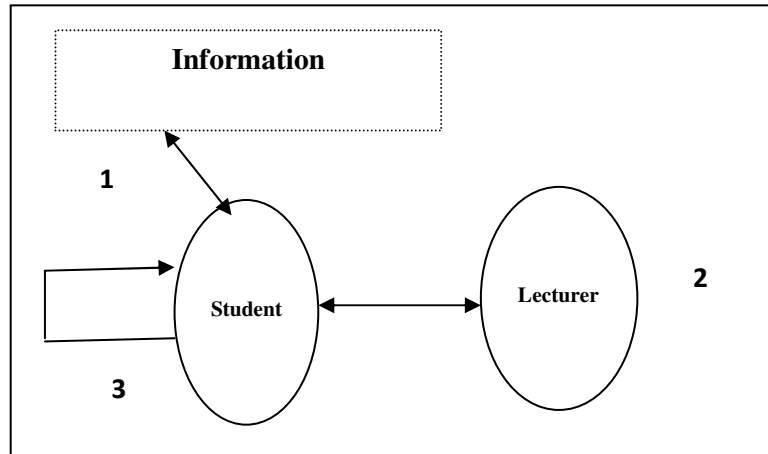


Figure 2. 3 types of Interactions (adapted from Sabry & Baldwin, 2003)

1. *Student-Information (S-I)*: The information here can be represented in one or more form (eg text, picture, simulation, sound, graphics, and/or video clip). Combining more than one presentation form can enhance learning in comparison with using one alone, for example, adding picture to spoken words (Mayer, 2001; Faraday and Sutcliffe, 1997). This form of interaction is considered the basis of all educational processes (Moore, 1989). The word *Information* is used here instead of the word *Content* described by Moore (1989) to indicate a wider and broader meaning to include the information and knowledge that is specific to course material (content) and/or non-course material that are relevant to course subject (Sabry and Baldwin, 2003). For example this can include the learner searching the web for information relevant to their learning task or interacting with the virtual lecture. The S-I interaction follows the three-way model of interactivity (3-WMI) by (Evans & Sabry, 2002) which involves a sequence of three correlated actions: *Initiation*, *Response* & *Feedback* (Figure 3). It can be student-initiated or computer-initiated (Schär and Kruegar, 2000).

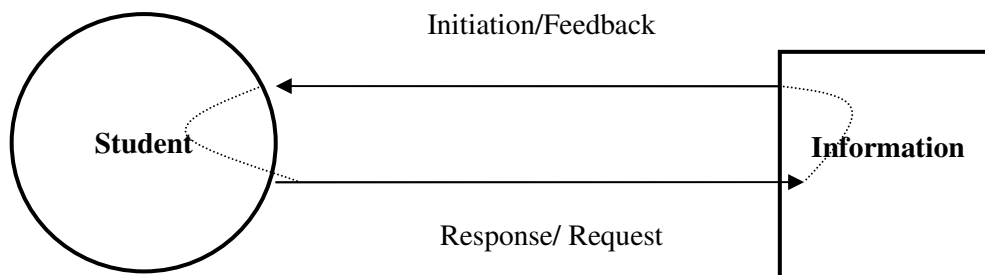


Figure 3. S-I Interaction (based on the 3-WMI model)

2. *Student-Lecturer (S-L)*: This type of interaction can take different forms, for example one-to-one and/or many-to-one. The adaptive role of a teacher is considered important for learning (Laurillard, 2002) to meet students' different needs (Laurillard, 2002; Ramsden, 1992). Some studies found that learners who interact regularly with their lecturer were more motivated, had better learning experiences (Garrison, 1990) and helped

students to recognise and resolve inconsistencies through dialogue (Cook, 2002). S-L interaction (Figure 4) can be in an asynchronous form (for example email and discussion board) or synchronous form (for example real time chat facilities, online tutorial, videoconferencing etc.). It can be student-initiated in some cases or lecturer-initiated.

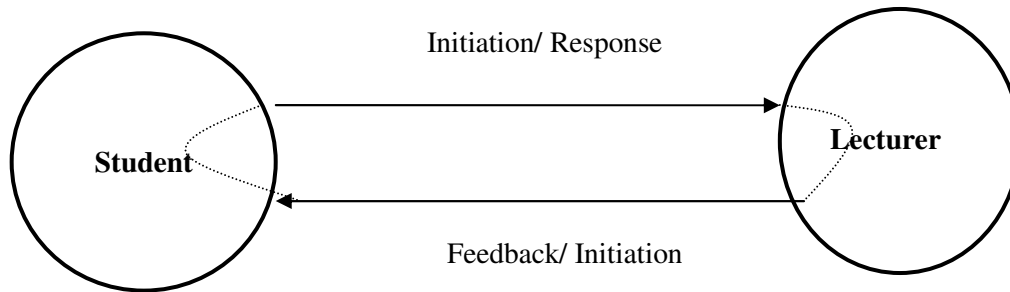


Figure 4. S-L Interaction

3. *Student-Student (S-S)*: Student-Student interaction (Figure 5) 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. According to some studies, learners who interact in a regular basis with other learners were found to be more motivated and had better learning experiences (Garrison, 1990). According to Dewey (1996), 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.

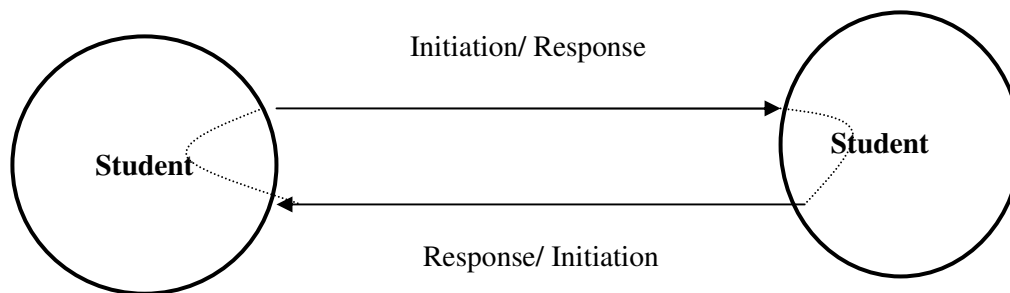


Figure 5. S-S Interaction

These three categories of interaction 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).

3 LEARNING STYLES INSTRUMENTS

Learning styles can be defined as “characteristic cognitive, affective, and psychological behaviours that serve as *relatively stable* indicators of how learners perceive, interact with, and respond to the learning environment” (Keefe, 1979, p. 4). Learning styles may differ from learning strategies, in the sense that, learning styles have 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). A wide range of literature investigates and explores the applicability and classifications of learning styles (see, for example, Riding and Rayner, 1998; Keefe, 1979; Curry, 1983; Kolb, 1976; Kolb, 1984; Witkin *et al*, 1977; Honey and Mumford, 1992; Honey and Mumford, 1986; Sadler-Smith, 1996; Felder and Silverman, 1988; Felder and Soloman, 1999). Many learning styles measuring instruments have been developed to identify individual learning styles such as the *LSI* "Learning Style Inventory" (Kolb, 1985), the *LSQ* "Learning Style Questionnaire" (Honey and Mumford, 1986), the *ASI* "Approaches to Study Inventory" (Entwhistle, 1979;1981), and the *ILS* "Index of Learning Style" (Felder and Silverman, 1988; Felder and Soloman, 1999). While there are advantages and disadvantages of each instrument, the measuring instrument developed by Soloman (1992) was chosen because of its relevance to the study in terms of the learning style dimension to be measured (sequential-global), ease of use (Montgomery, 1995), and the variety of information available that covers several aspects of it. However, caution has to be taken as the instrument is still being tested for validation and reliability. Also, according to Felder and Soloman (1999), while the learning style profile of a learner provides an indication of probabilities and possible tendencies, it is not an evaluation of learner's suitability or unsuitability for a particular subject, discipline, or profession. They further add that labelling learners in this way is not only misleading but may be damaging. Felder and Soloman's (1999) Index of Learning Styles, which is based on Felder and Silverman's learning style model (1988), synthesises findings from several research studies in developing a learning style model. The instrument measures four learning style dimensions, through a 44-element questionnaire (11 elements to measure each dimension) that develops the preference profile of the learner. This paper is concerned with the sequential-global dimension which deals with the learner's progress towards understanding. Table 1 includes a description of the categorisation and preferences of this dimension. Each learning style measured by the instrument ranges between three strength levels (see Table 2) using a scoring sheet provided by the instrument.

Dimensions	Sequential (SEQ)	Global (GLO)
Categorization	Progress toward understanding: in a logical and small incremental steps	Progress toward understanding: in non-linear way, large jumps, holistically
Preferences	Tend to gain understanding/find solutions in linear manner, with steps following each other logically. Sequential learners may not fully understand the material or establish a link with other parts, but able to know a lot about specific aspects of a subject.	Tend to learn in large jumps, absorb material almost randomly, and may be able to solve complex problems quickly. Strongly global learners may be fuzzy about details or have serious difficulties understanding until they have the big picture.

Table 1. Sequential-global learning style dimension based on Felder (1993)

Strength Level	Description
Strong preference (s)	The learner may have difficulties learning if the teaching style used does not accommodate his/her preferred learning style of that dimension
Moderate preference (m)	The learner will learn more easily using a teaching style that accommodates his/her preferred learning style of that dimension.
Mild preference (b)	The learner will have no learning difficulties if the teaching style used goes towards each side of that dimension (generally balanced).

Table 2. Strength level scale (based on Felder and Soloman, 1999)

4 BACKGROUND TO THE RESEARCH

The Gulf region is a region of great diversity, within which a great number of educational institutions have been developed and more being developed whether or not in cooperation or partnership agreement with European or international institutions. Pre-entry courses are designed to prepare secondary school graduates with English language skills required for Higher Diploma and Bachelor Degree programs that are English language based. Having said that, through the eyes of a faculty-as-observer there is still a great demand for English language support throughout the student's education along with the need for applying different learning and teaching methods to accommodate different learners' needs and to ensure students digestion and understanding of different subjects. Also, as a general observation, female students seem to put more effort and time into their university work, are more motivated towards their learning and generally achieve higher grades compared with male students. Historically, factors such as religion, cultural and social traditions had great effect on female students whether in work related or education related issues, for example limitations of geographic mobility and ability to travel as well as segregation related matters (Al-Khatib, 2007). Further, in Arab societies, however increasingly changing, female students generally spend more time at home, leading to possibly more time available for studying (Al-Khateeb, 2001).

A recent study on the GCC's public expenditure on education revealed that the Gulf Cooperation Council (GCC) countries were determined to achieve the world's highest levels of admission rates to institutions of higher education (UAE Interact, 2007b). The UAE currently offers a comprehensive education to all male and female students. Despite that several thousand students, of both sexes, pursue courses of higher education abroad at Government expense; there is an extensive private education sector that is growing to further improve the educational environment for all students (UAE Interact, 2007). Modification and updating are educational constant strategies to ensure high quality of the programmes developed, with particular focus on state of the art IT resources at all levels (Fox, 2007; MOHE, 2007). IT education in the formative years has become a major priority for the UAE (UAE Interact, 2007). Some universities signed a partnership agreement to establish an e-Learning Center of Excellence (Ame Info, 2006). However, it is vital to realise that technology is only one of the components of an effective e-learning system, leading to the need for a detailed and appropriate research of learners and users' needs (Baldwin and Sabry, 2003; Computing, 2005). Leading figures at some of the Gulf's top companies and institutions expressed their dissatisfaction with the region's higher education system in terms of producing graduates lack many of the skills and risk-taking entrepreneurial spirit needed for the cutting edge private sector employment and that the education system was not producing what the economy needs (Gulf News, 2007). Although the UAE has achieved much in the field of education there was a real awareness that constant updating of policy and continual investment in infrastructure was required to ensure that graduates were properly equipped to enter the workforce and assist in the country's development (Fox, 2007). Consequently, the Ministry of Education released a draft policy document outlining a strategy for educational development in the UAE up to the year 2020 based on several five - year plans. The strategy aimed to introduce the latest information technology at all levels. The focus of attention would be primarily on the needs of students, especially through the promotion of self-learning, use of technology and continuous education programs (UAE-GOV, 2007).

5 POPULATION AND RESEARCH METHODOLOGY

The investigation conducted is of a qualitative nature, although quantitative analysis methods have been used. It is based on self-reporting preferences; to explore students preferred learning styles and possible relationships with other individual differences, rather than to obtain statistically significant results. The implications can have some generalisation of the results (Yin, 1994) which can be validated by further research.

The study took place at a UAE university involving undergraduate students with different abilities and background, undertaking a degree in Information Systems. The questionnaire included the Index of Learning Style instrument. Students filled the questionnaire online and printed the results, taking approx 15 minutes. Out of 120 randomly selected students, 80 completed the questionnaire, a response rate of 67%. The sample included 42 female and 38 male students. The students spanned a range of abilities and backgrounds, and the majority of students were extrinsically

rather than intrinsically motivated, with high number of working students and UAE nationals. English was their second language and generally the majority did not possess high level of English language skills at entry and had to take pre-entry English language courses to improve and/or strengthen their English skills to cope with their degree courses that are taught entirely in English. Consequently, this had some implications on their understanding of different topics on one hand, and understanding/ answering exam questions on the other hand, leading to frustration and shorter concentration span.

This put tremendous pressure on both students and faculty throughout the four years degree of study to accommodate and deal with language related difficulties and learning speed. The teaching methods used are traditional face to face with no computer-based learning environment available at the time. Prior to filling the questionnaire, learners were informed of the research objectives, and that the results of the questionnaire would not be available to anyone other than the researcher. The questionnaire was anonymous in order to encourage learners to supply such details as freely and accurately as possible, however they were encouraged to write their names for follow up purposes. Data was analysed by drawing up a profile of learning styles and making a comparison between these and the learning style preferences of previous study in the UK. Results were analysed determining different strength scales (mild, moderate, and strong).

6 RESULTS

Overall, the population exhibited equal tendency towards both styles (figure 6), the Sequential (50%) and the Global (50%). In terms of gender differences, the female population displayed higher tendency towards the sequential learning style (57%) while the male population displayed higher tendency towards the global style (58%), see figure 7.

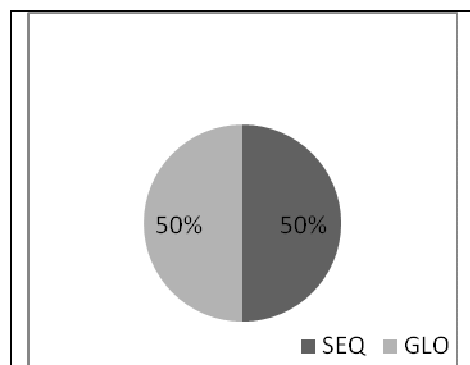


Figure 6. Overall tendency towards both styles

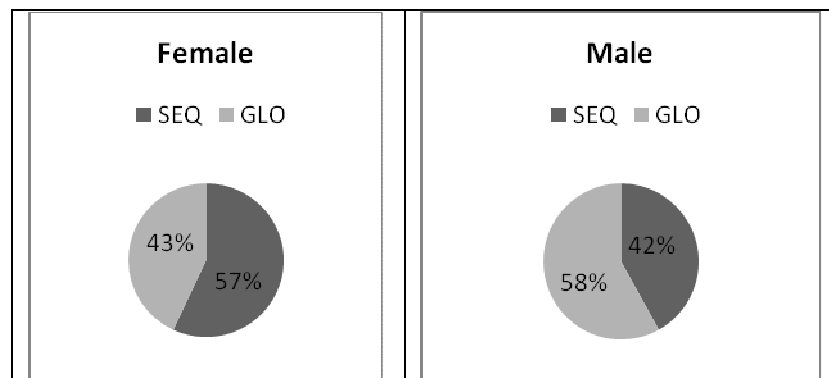


Figure 7. Gender differences

In terms of overall strength level breakdown of each style (i.e. Mild, Moderate & Strong), 14% of the population were found to have stronger tendencies (ranging from moderate to strong) towards each learning style (see figure 8). In terms of gender differences (figure 9), the male population exhibited higher tendency (16%) towards the global (m-s) and the female slightly higher (14%) sequential (m-s).

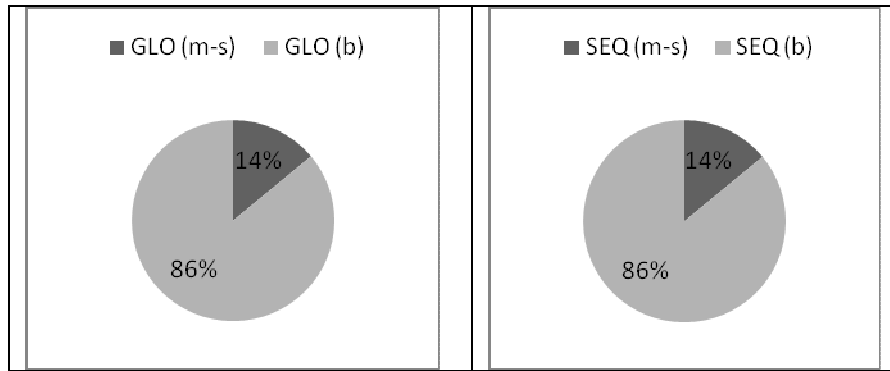


Figure 8. Strength level breakdown

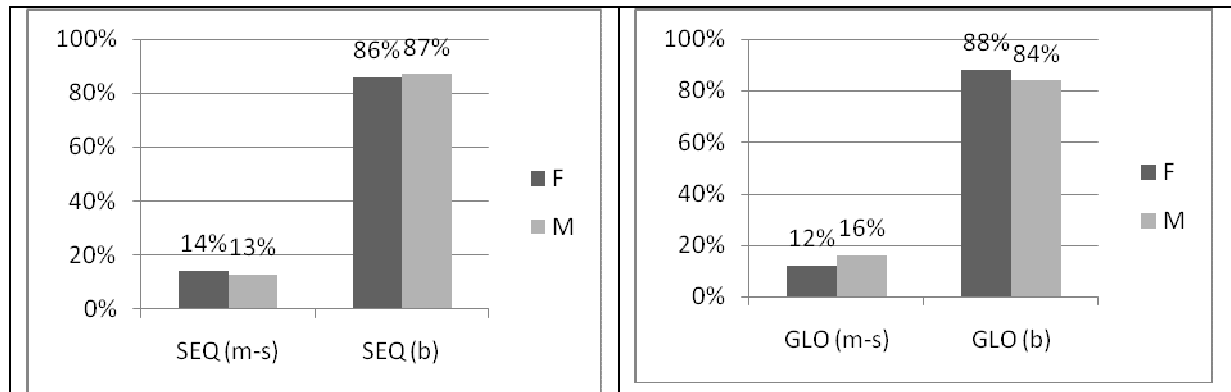


Figure 9. Strength level breakdown (gender differences)

7 DISCUSSION AND THOUGHTS

The results show overall equal tendency towards both learning styles. This is different from previous study conducted in a UK university (Sabry and Baldwin, 2003) where there were higher tendency towards the sequential style than the global style. The results also show that 14% of the population have strong-moderate tendencies, while 86% exhibited a more balanced style (mild). This is also different from previous study conducted in a UK university (Sabry and Baldwin, 2003) where there were higher moderate-strong tendency towards the sequential style than the global style.

Despite that the results indicate that the majority of students may generally benefit and/or have no learning difficulties if the teaching design goes towards either side or to both sides of that dimension, 14% are expected to be affected and/or further benefit from matching and accommodating their preferred learning style. For example, in terms of S-I interaction for Sequential learners, who tend to gain understanding, find solutions in linear manner, with steps following each other logically, it is essential to include activities and interactive exercises which allow learners to take a linear approach through step-by step progression of topics such as the use of structured type presentation. However, for Global learners who tend to learn in large blocks and absorb material seemingly randomly, it will be necessary to provide the learner with the big picture, and connections between the parts. For example by providing a section on the virtual lecture that provides an overview of main topics in the module, once a topic is chosen a list (overview) of subtopics is presented in the section, providing mind and concept maps, menus etc (figure 10).

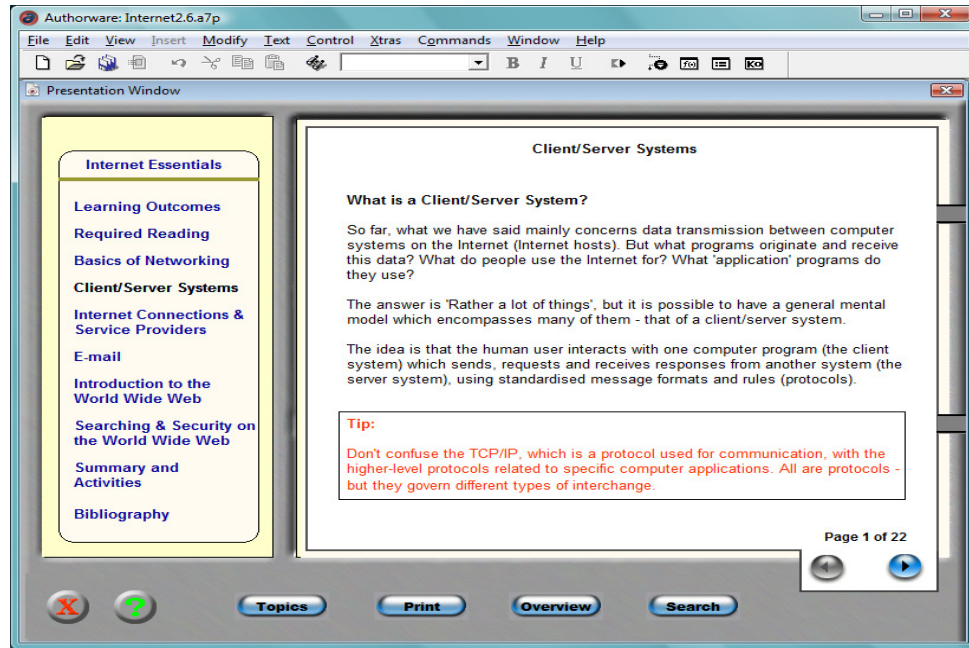


Figure 10. Adapted from MSc course in Multimedia for eCommerce, Brunel University 2004©

In terms of L-L and L-T interaction, providing a variety of asynchronous interactions through, for example, the use of discussion board for different activities such as different group assignments, discussions linked to each topic, brainstorming, activities and problem solving exercises can help Sequential learners to get involved in a progressive manner and be able to see the development of the argument, while also giving opportunities for Global learners to obtain a holistic view of the discussion through the linking of different discussions to subject topics that constitute the whole (figure 11). WebCT ®TM and Blackboard ®TM learning environments are good examples of a learning environment that integrates different educational tools that help the learner to interact with fellow learner, tutor, and learning material (WebCT, 2003; Yaskin & Everhart, 2002).

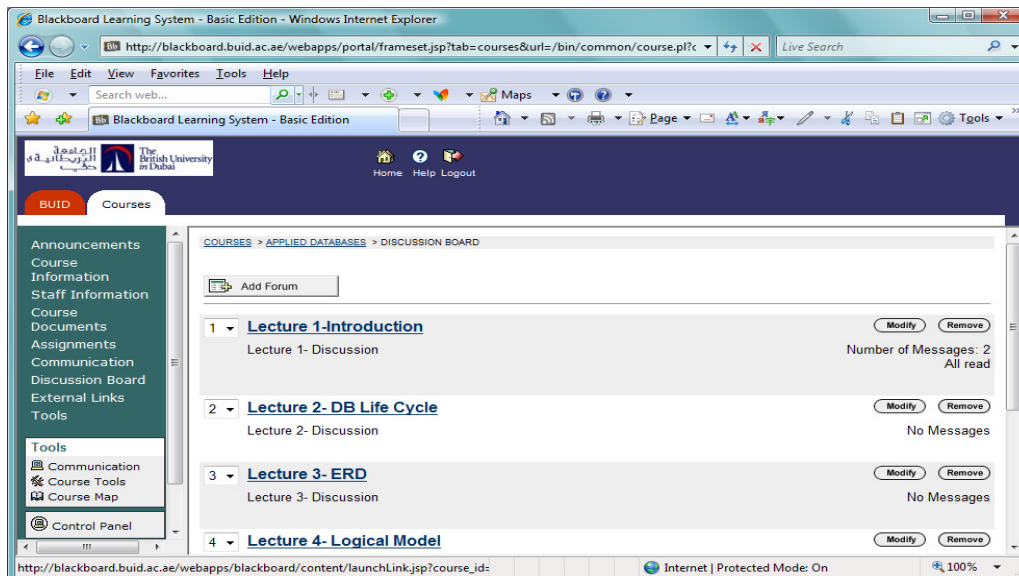


Figure 11. Topics discussion (Adapted from MSc course in ITM, British University in Dubai BUiD 2007©)

Further, one of the useful Blackboard tools that can be used is to link the content section to the discussion board, as well –organised course material and the appropriate grouping of activities in a logical and consistent manner can help students in their understanding and navigation of the course material. (Fredericksen *et al*, 2000).

To cater for sequential learners who prefer to learn through linear structures, to ensure a clear progression of topics, building upon previous knowledge. For example provide slide show style presentation. However, for global learners, a mental map through which the student can be aware of the big picture throughout (Table 3).

Learning style	ILS Design Suggestions
Sequential	Allowing students to take a linear approach through step-by-step progression of topics such as the use of slide show style presentation. In terms of Virtual Lectures, providing a section on the screen that provides an overview of main topics in the module in a sequential order or through numbering of topics, once a topic is chosen a list (overview) of subtopics is presented in the section, again in a sequential order or through numbering, etc. Further, connecting course contents or topics to discussion boards when and where it is appropriate, for allowing both S-S & S-L interactions. Use for example virtual learning environments (VLE) such as WebCT / Blackboard and others can allow for the 3 types of interactions (S-I, S-S & S-L).
Global	Allowing the student to see the big picture, and connections between the parts. For example by providing a section on the screen that provides an overview of main topics in the module, once a topic is chosen a list (overview) of subtopics is presented in the section. Also, using concept maps can reinforce students' understanding and learning, and enables visualization of key concepts and summarizes their relationship, which can contain where appropriate links for S-I, S-S & S-L interactions. As, above, the use of virtual learning environments (VLE) such as WebCT / Blackboard and others can allow for the 3 types of interactions (S-I, S-S & S-L).

Table 3. ILSs Design Suggestions

8 THE BALANCE AND BLEND MODEL (BBM)

With the rapid development of ILSs as information systems for learning purposes, the role of learning styles for computer-based learning is becoming part of education literature. Therefore, the design of ILSs should cater for these styles in a balanced way to match such preferences (Sabry, 2005; Baldwin and Sabry, 2003). According to Felder (1996), teaching exclusively using students' 'less' preferred learning style, may result in high student's level of frustration and discomfort which may interfere with their learning, while teaching exclusively using students' 'more' preferred styles, the students may not develop the skills required to reach their potential for achievement. However, the question here is: To what extent the styles exhibited should be adapted? And to what extent the non-exhibited or weak styles should be considered for developing necessary skills? The BBM model (Sabry, 2005) or the BLADE model (Baldwin and Sabry, 2003) consider these multiple tasks, adapting to students learning styles and developing required skills as well as maintaining the right balance between them, which forms an important part of the 'interaction' component of ILSs. The BBM model is concerned with a *carefully balanced* design of ILSs that caters not only for students' preferred learning styles, but also considers exposing students to other styles that may expand their abilities and skills that are required to perform certain tasks. It is not about throwing the same bag that contain different activities which fit all learning styles at every group on the assumption that their learning styles are different anyway (Mumford, 1994). It is based on the actual profile of learning styles exhibited by a class or cohort, which could differ in degree of strength of a particular style or total percentage from other classes or cohorts. The Model (See Figure 12) is not a quick fix or answer to all problems, but a trigger to establish the right balance between accommodating and developing in the context of ILSs. It is based on the following:

1. Identifying the Learning Style profile exhibited by students. This is essentially to perform diagnostic actions before prescribing any remedial actions.
2. Identifying the skills that are required to be developed according to the aims and objectives of the course. For example, some of the qualities of competent engineers and scientists include being observant, methodical, and careful (*sensing* style), innovative, inclined to go beyond facts to interpretation and theory (*intuitive* style), and have both *visual* and *verbal* skills (Felder, 1996).
3. Identifying the areas of the course that should be matched or adapted to student learning styles, and identifying the extent to which they should be accommodated based on the skills that are essential to be developed for each module or course.

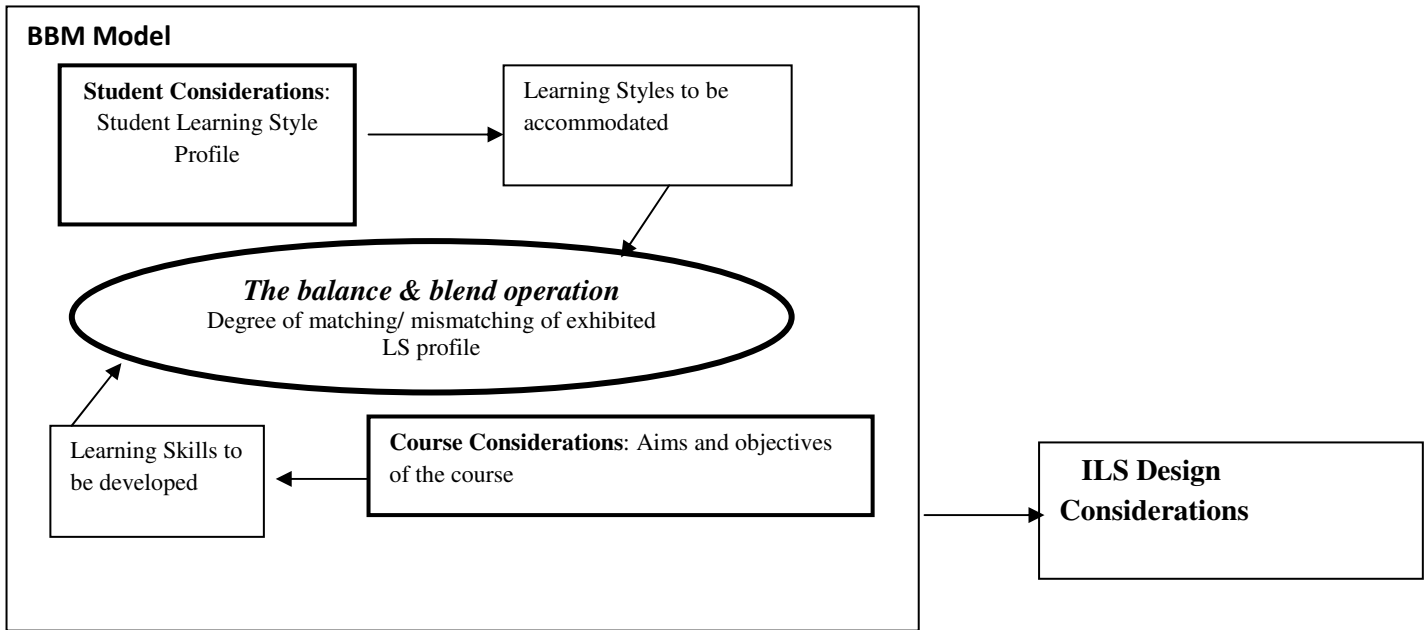


Figure 12. Summarised version of the BBM model (Balance and Blend Model)

Based on identifying the above, a balanced model of instructional styles can be developed to inform the design of ILS. This will help determining the interactivity level, balanced and blended S-I, S-L & S-S interactions, and the use of multimedia as required for the learning system, including manipulation and interaction with words, numbers, and pictures (Kristof & Satran, 1995). According to Felder (1996) some engineering educators have applied and examined students learning styles and identified both students' learning weaknesses and strength, and acted upon their findings through adapting matching teaching styles, and helping students to become aware of their preferred learning styles to achieve more effective and efficient ways of learning.

9 CONCLUSIONS AND FUTURE WORK

This paper aims to present and encourage research relevant to universities and colleges in the Arabian Gulf Region including cultural, students' learning preferences and the use of information and communication technology. It particularly focused on interactive learning in relation to learning styles. It explored the learning styles profile of undergraduate students as part of a continuous research in Interactive Learning Systems (ILSs) design.

The results show that the population had equal preference towards sequential and global learning styles, and a smaller percentage of them had moderate-strong tendency to one of the learning styles. It is suggested, therefore, that the learning interactions design should take into account such variation in learning styles in relation to the three types of interactions explained above, taking into consideration learners' in order to provide a more balanced interactive learning environment for more effective learning. Some design issues have been explored in the discussion section above, however, there is no quick fix or answer to all problems, but understanding about learners learning styles can help in establishing the right balance between accommodating learning styles and developing important skills in the context of ILSs. It is believed that the use of ILSs can support the population investigated in terms of accommodating both the sequential and global learning styles as well as developing the skills required. Further it is believed here that through the use of interactive self-assessment facilities and interactive dictionaries of ILSs can support the population's understanding through the feedback it provides. It is also believed that the use of ILSs can provide female students as well as working students the flexibility in terms of time, pace and place for the three types of learning interactions.

An effective ILS design, should take account of students' differences and good teaching principles. The underlying issue is that students learn more effectively when information is presented in a manner that fits with their preferred

method of acquiring and processing information. At the same time, course objectives and subject-related skills should not be ignored, but encouraged in a carefully balanced manner with students' own preferred styles (BBM model). The BBM is based on three fundamental considerations: the actual learning styles exhibited by students, the learning skills that need to be developed, and the actual percentage of each learning style that need to be accommodated. Such a carefully balanced approach not only may help students to respond more effectively to different learning situations, but also may act as building block towards learning how to learn and the formation of a more independent learner. Taking into consideration the BBM model may help to enhance the matchability and adaptivity of ILSs in a balanced and purposeful way rather than randomly, to achieve a more precise and calculated approach to the design.

This study stresses that learning style instruments can help to highlight to lecturers and education designers some areas of possible significant importance to students learning. Learning styles instruments can be used to diagnose and predict probable difficulties that might be experienced by some students when using ILSs at early stages of the course in order to take necessary remedial actions before it is too late. This is due that the computer screen at any one time can hold a limited amount of learning material. Thus, the screen space is very valuable and should be used as efficiently and effectively as possible to maximise learning from the material presented. Therefore, design decisions have to be made in the amount of space that can be allocated to different types of activities.

Further research is needed to examine the same students longitudinally (Panel type survey) and to experiment different types of computer-based learning interactions to obtain more specific and accurate results that reveal changes over time. The research outlined in this paper is an attempt towards more understanding of learners and is hoped to lead to improvements in the design of ILSs and more active participation by high percentage of students that in turn should lead to important gains in the acceptability and usefulness of ILSs as the awareness of the pedagogical needs of different learning styles can lead to more effective ILSs. Research will be needed to further examine different cultures, gender differences and the extent to which some of the findings may be generalised for the purpose of ILSs design. Much work has been done on learning styles but a relatively modest body of literature has focused on the student English language level in relation to learning styles preferences for the purpose of ILSs design. Further, research is needed to examine different applications of the BBM model and different learning interactions that best support students that English is not their first language in order to create a fairer system and avoid penalizing the student for his/her English language weakness rather than assessing their subject learning and at the same time maintaining the quality of education. Research is needed to examine the effect of ILS-based methods such as self-assessment questions and feedback, use of multimedia tools and learning by example to overcome the language barrier and the consequent concentration span and frustration problems as well as speeding up the learning process and improving their understanding.

Future work will include the investigation of other learning style dimensions (such as: Active- Reflective, and Visual-Verbal) in relation to the three interaction types and also investigating other individual differences such as gender, culture, prior knowledge, special needs, working students and language fluency in relation to learning styles and the implications on ILSs design.

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ACKNOWLEDGEMENT

We would like to thank Professor Richard Felder for allowing the use of the ILS instrument and all the supportive literature provided on his homepage.