Implementation, use and analysis of open source learning management system "Moodle" and e-learning for the deaf in Jordan

By

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Declaration

I, the undersigned, hereby declare that this dissertation entitled, "*Implementation, use and analysis of open source learning management system "Moodle" and e-learning for the deaf in Jordan*" is my own work and that all the sources I have used or quoted have been indicated or acknowledged by means of completed references.

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Sufian M. I. Khwaldeh Date 18/3/2011

Abstracts

When learning mathematics, deaf children of primary school age experience difficulties due to their disability. In Jordan, little research has been undertaken to understand the problems facing deaf children and their teachers. Frequently, children are educated in special schools for the deaf; the majority of deaf children tend not to be integrated into mainstream education although efforts are made to incorporate them into the system. Teachers in the main stream education system rarely have knowledge and experience to enable deaf students to reach their full potential.

The methodological approach used in this research is a mixed one consisting of action research and Human Computer interaction (HCI) research. The target group was deaf children aged nine years (at the third grade) and their teachers in Jordanian schools. Mathematics was chosen as the main focus of this study because it is a universal subject with its own concepts and rules and at this level the teachers in the school have sufficient knowledge and experience to teach mathematics topics competently. In order to obtain a better understanding of the problems faced by teachers and the deaf children in learning mathematics, semi-structured interviews were undertaken and questionnaires distributed to teachers. The main aim at that stage of research was to explore the current use and status of the e-learning environment and LMS within the Jordanian schools for the deaf in Jordan. In later stages of this research, semi-structured interviews and questionnaires were used again to ascertain the effectiveness, usability and readiness of the adopted e-learning environment "Moodle. Finally pre-tests and post-tests used to assess the effectiveness of the e-learning environment and LMS. It is important to note that it was not intended to work with the children directly but were used as test subjects.

Based on the requirements and recommendations of the teachers of the deaf, a key requirements scheme was developed. Four open source e-learning environments and LMS evaluated against the developed key requirements. The evaluation was based on a software engineering approache. The outcome of that evaluation was the adoption of an open source e-learning environment and LMS called "Moodle". Moodle was presented to the teachers for the purpose of testing it. It was found it is the most suitable e-learning environment and LMS to be adapted for use by deaf children in Jordan based on the teachers requirements. Then Moodle was presented to the deaf children's to use during this research.

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This thesis is dedicated to my late grandfather may his soul rest in peace, parents, brothers and sisters, nephews, nieces and friends

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CHAPTER 1

INTRODUCTION

1.1. BACKGROUND

According to Gentzoglanis (2007), the advancement in Information and Communication Technology (ICT) field has witnessed huge growth in the last decade by being applied into different fields and practices. ICT has brought a range of services and applications to the branches of knowledge and shaped human modern life in various aspects through the fetching and endorsing advantages especially to developing countries like Jordan. Despite all of the benefits, there are also a number of challenges and obstacles for such countries.

Utilising ICT in the Arab world including Jordan has been tackled in light many challenges due to direct and indirect reasons mainly associated with politics which has contributed in delaying the development in the Arab world and particularly in Jordan. Regional politics have contributed to massive and perhaps unnecessary spending on weapons, wars and lately revolutions. Hence, there has been much less focus on economic and social development which has resulted in poverty, high rate of illiteracy and weak infrastructure and such deficiencies have resulted in poor planning of services provided for the people of the country's including educational provisions.

Despite the facts mentioned above and as a result of the prominent effects of ICT in the educational field through the introduction of e-learning (electronic learning) and its applications, the Jordanian educational system and other systems in Arab countries have received evident consideration lately. This is due to the urgent desire of these countries to promote existing educational programs with the aim of meeting best practices and international standards (Weber, 2010).

The introduction of e-learning and its applications such as Learning Management Systems (LMS) and Learning Content Management System (LCMS) have opened the door wide open to catch-up with other advanced educational systems in developed countries and to provide better educational outcomes. Moreover, it has enabled the learners in developing

countries to have similar educational and learning experience to their counterparts in the developed countries.

The Arab Knowledge Report (2009) indicates that the Arab countries progressed in most of the key aspects of ICT particularly in the investment in ICT infrastructure scoring higher than other regions of the world in 2008. However, according to the same report such levels vary from one Arab country to another resulting in an inequality of ICT utilisation. This is due to the economic situation of Arab countries that control the spending on the adoption and utilisation of ICT. This will have an effect on the societies in each Arab country.

A major obstacle facing the adoption and use of e-learning and LMS in the Arab world including Jordan is the lack of specialised Arabic e-learning and LMS systems. In addition there is a general lack of Arabic learning content and objects (The Arab knowledge Report, 2009). This report stressed the lack of research and particularly in the context of e-learning and its application in the Arab world (including Jordan) which presents more challenges and obstacles do to the uniqueness of requirements and nature of the Arab world.

In the Arab world, there is a clear deficiency of specialised e-learning and LMS systems for learners who require special arrangements as to meet their special-needs such as deaf and blind learners. Unfortunately, most Arab companies relate to ICT and software development does not see great financial benefits from developing LMS, multimedia software and e-learning systems for users with special needs such as deaf users. This market sector is not a profitable and thus little financial/human resource is allocated to it for commercial reasons (AL-Ja'am et al, 2008).

1.2. MOTIVATION

In the classroom, deaf children face some difficulties in learning. For example, when a teacher demonstrates on the black board, they usually face the wall, making lip-reading impossible. Unless deaf children have a note-taker, they will not be able to write down the necessary information and watch the teacher/interpreter/lip-speaker at the same time. Deaf children in Jordan face even greater problems due to lack of educational infrastructure, resources and specialist provisions (Khwaldeh & Shah, 2010). Having a family member

who works with the deaf in Jordan gave the researcher a clear perspective on the situation and problems facing deaf children in class and in particular mathematics.

The National Team for Early Childhood Development (NTECD) conducted a study in Jordan. This study showed and acknowledged the lack of provision for deaf children in schools. For example, there are few educational tools that support the literacy and learning in deaf children education (NTECD, 2000). In addition, resource rooms are unfairly geographically distributed in Jordan. Inaccessibility of information through television (due to few subtitles) turns into a vicious cycle that is difficult to break (Drigas & Kouremenos, 2005a).

According to Abu Shaira (2007) educating the deaf children in Jordan and in the Arab world is relatively new. There is a lack of resource that discusses this issue in Jordan whether in Arabic or English literature. Abu Shaira stated that "*The topic of teaching the deaf is new and the idea is not one that is Arabic, in origin. Therefore, there is nothing available which discusses this topic in the Arabic literature, new or old (according to the researcher's readings and his communication with experts of this field)*". According to Matar & Hunaiti (2009), the use and implementation of e-learning and its applications in the Arab World suffers from low adoption of such technology. This lack of adoption is clear at all educational levels.

A number of studies in the past 20 years revealed that deaf and hard-of-hearing pupils in classrooms struggle with reading, writing and communication (Long et al, 2007; Antia, Reed, & Kreimeyer, 2005; Long & Beil, 2005). The majority of deaf children show a serious delay in mathematical learning (Drigas et al, 2005b). Wood et al (1983) and Nunes and Moreno (1998, 2000) found that the average marks in mathematics for deaf children in the age range 8-15 is one standard deviation below the average for hearing children. Therefore (50%) of the deaf achieve equally to the weakest 15% of the hearing pupils (Nunes and Moreno, 1998). Thus, the majority of deaf children leave school with insufficient mathematical skills. Deaf pupils who are at the age of (16-17) years leave school, in the UK, with a mathematical age between (10-12.5) years (Hine, 1970; Wood et al., 1986). However, there appears to be no direct connection between deafness and

mathematical difficulties (Zarfaty et al, 2004) i.e. deaf children's capacity for learning is no different to hearing children.

It is well known that e-learning platforms and their tools have contributed to improving education. In addition, e-learning platforms increased deaf people's chances and abilities to step further into their education, therefore improving their lives (Drigas & Kouremenos, 2005a). The provision for the deaf learners could be improved through the use of e-learning and Multimedia (Khwaldeh, Matar & Huniti, 2007). ICT tools have essential features that aid teaching and learning, such as the interactivity between the learning elements (instructor, learner and topic being learned) and multiple representations (Leung, 2006).

In order to highlight this issue, this research commenced to explore the current status of the adoption of e-learning into deaf education in Jordan and to outline the main challenges and obstacles. Moreover, this research aimed to explore the effectiveness of e-learning and LMS in facilitating mathematics learning for the deaf pupils in Jordan and ultimately could also be used in other subjects such as physics, chemistry and biology. This research also outlines problems that deaf pupils and their teachers in Jordan face when learning mathematics. Some of the problems will also be common to other subjects.

1.3. RESEARCH AIM AND OBJECTIVES

This research aimed to examine the current use of e-learning and LMS in teaching mathematics to deaf pupils in Jordan. This has been achieved by exploring the current status and use of the e-learning and LMS within the Jordanian schools for the deaf and to understand more fully the problems and challenges teachers and the deaf children face when learning mathematics. In addition, by examining the suitability of current open source LMS in meeting the requirements of deaf pupils and their teachers in Jordan and to assess the effectiveness of using e-learning and LMS and initiating the development of guidelines in adopting and using e-learning environment and LMS for deaf pupils. This was accomplished by aiming to achieve the following objectives.

1. Evaluating the current status and use of e-learning and LMS within the Jordanian context and investigating the current status and use of the e-learning and LMS in the Arab world and globally.
2. To explore the suitability of current open source LMS in meeting the requirements of deaf pupils and their teachers in learning mathematics.
3. To compare the effectiveness of e-learning and LMS before and after using e-learning and LMS.
4. Initiating and developing a model and guidelines in adopting and using e-learning environment and LMS for deaf pupils.

The methodological approach used in this research is mixed methods consisted of action research and Human-computer interaction (HCI) related research. Therefore, it is a systematic approach using questionnaires, interviews, pre/post-test and the observing the teachers and deaf pupils through the teaching tools in Moodle (web-based observation).

The target group is deaf children aged eight-ten years old and their teachers in Jordanian schools. Two schools have been the subject of a pilot study out of the 12 schools for the deaf in Jordan and five schools have been the subject of this research. Semi-structured interviews have been undertaken and questionnaires have been distributed to teachers. The main aim of using interviews and questionnaires was to explore the current use of the e-learning environments and LMS within the Jordanian context and to understand more fully the problems faced by teachers and the deaf children when learning mathematics. In latter stages of this research, questionnaires were used again to ascertain the effectiveness of the adopted e-learning environment from the teachers' point of view. Finally, the pre-tests and post-tests were used to assess the effectiveness of the e-learning environment and LMS.

In this thesis e-learning has focused on deaf people in the age range 8-10 years old in Jordan and highlight the use, analysis and evaluation of e-learning and LMS's for the deaf. Even though, it can be applied to a large number of subject disciplines and different age groups, the focus of this study has been mathematics because it is a universal subject and nature of the language of mathematics employed internationally. The subject enables language and cultural barriers to be minimised.

In order to conduct this research, following research design was used:

1. Ascertain the current use of ICT, e-learning environment and LMS in the classrooms and schools for the deaf in Jordan.
2. Understand the problems facing these deaf children in Jordan when being taught some specific areas of mathematics.
3. Evaluating the idea of adopting an open source LMS to address the developed key requirements and teacher responses regarding what they expected when using e-learning and LMS.
4. Implementing the LMS by introducing it and the proposed e-learning environment to the teachers and obtaining their feedback. This includes providing workshops on how to use the e-learning environment and LMS.
5. Pre-testing deaf pupils.
6. Implementing the chosen open source LMS for use by the teachers and their deaf pupils.
7. Assessing the LMS system through the use of a questionnaire and interviews conducted with the teachers, tracking the use and activities of users, and assessing the e-learning through post-testing the deaf pupils.
8. Conclusions and recommendations.

1.4. ORIGINAL CONTRIBUTION TO KNOWLEDGE

This research study has original contribution to knowledge. The following points are presented as contributions to knowledge:

- Results derived from the investigation and analysis of the status and use of e-learning in the Jordanian schools for the deaf as such results helped in identifying the main requirements of this research. The gap identified in this study in the literature can be used in the future by governments, organizations, e-learning companies and future research in targeting financial and human resources to support deaf education through e-learning and LMS in the Arab world.

- The methodological approach in choosing and evaluating LMS for the purpose of adoption could be applied to any country, educational institution and future research projects.
- The systematic and methodological approaches used in this research created guidelines to adopt e-learning and LMS. They can be used for further research in different countries or in other research disciplines.
- Some of the outcome of this research was presented to the public via a number of papers, presentations sand conferences.

1.5. STRUCTURE OF THE THESIS

***Chapter One*:** Provides an overview of the entire thesis.

***Chapter Two*:** This chapter outlines the background to research by reviewing the literature regarding the definitions of deaf and deafness, deafness models and what has been adopted in Jordan, the communication methods of/with deaf individuals, a historical overview about the deaf education and some issue surrounding it. This chapter also presents Jordan as country, its educational system, the latest statistical information about the deaf and their education in Jordan. It also covers Jordanian efforts in providing education for those with special needs, and the deaf in particular, the religious and cultural attitudes towards deaf people in Jordan and the Jordanian government's efforts towards the integration and implantation of ICT tools and e-learning within the country's educational system.

***Chapter Three*:** This chapter outlines the background of research by reviewing the literature regarding learning concept and its definitions and relationship with education, learning theories and implications in the e-learning field. It also gives a historical perspective about the use of ICT in education, the terminologies used to describe the use of ICT in education, e-learning definitions, classifications and components, e-learning systems such as LMS and LCMS. An overview about the recent use of e-learning by the deaf is presented. Finally, it presents some of the trends in e-learning that are expected to evolve in the near future.

The findings in chapter two and three are used to set the background to outline the need for the adoption of e-learning and LMS to help deaf pupils in Jordan and to fill research gaps in this field.

***Chapter Four*:** In this chapter, a description about the methodologies used in this research, namely action research and HCI. A brief discussion of the chosen epistemologies and the rationale behind using them is presented with the aim of understanding the philosophical background of the research. A brief discussion of the chosen epistemologies and the rationale behind using them is presented. This chapter also describes the data gathering tools used in this research, questionnaires, interviews, observation and pre-/post-tests. The data analysis methods were discussed.

***Chapter Five*:** Presents e-learning status use in Jordanian schools for the deaf. An explanation to define the methodology used to perform the survey used in the study is given. Results of the survey are presented and discussed. The interviews with the teachers and their outcomes regarding the challenges and obstacles in learning mathematics and using e-learning in the Jordanian schools for the deaf have been presented. A general conclusion is drawn that presents the facts about the e-learning status and use in the participating schools and the development of the end user criteria (key requirement) for the LMS and the e-learning system.

***Chapter Six*:** Presents the evaluation process of four LMS. This involved examining many factors in relation to the key requirements, These can be split into various categories, such as language support, hardware/software specifications, RDBMS, LMS standards and specifications compliance, administrative tools, assessment tools, collaboration and communications tools, and customisability.

***Chapter Seven*:** Presents and describes the implementation strategy adopted in this research in order to implement Moodle starting from approaching the Ministry of Education in Jordan and Schools in Jordan. It describes the procedures that were followed in terms of recruiting participants and setting up participation procedures, description of Moodle and its functionalities, the users' type, the course format, the course resources and activities within Moodle. It also describes the process and stages of piloting Moodle.

***Chapter Eight*:** Presents the evaluation stage involved, with teachers/instructors providing feedback on their experiences using and interacting with the Moodle, the evaluation for students' achievements using pre-post testing and the results of users tracking.

***Chapter Nine*:** Presents the conclusions of this study and suggests different enhancements and ideas for future work.

CHAPTER 2

DEAFNESS AND JORDANIAN CONTEXT

2.1. INTRODUCTION

Deafness has been a common circumstance throughout the history of humanity. It affects many people in all communities, races and societies, regardless of gender. Although deafness has always been present, its occurrence in ancient, classical and medieval times was always a matter for speculation (Moores, 2001).

From the medical point of view, the deaf population globally is estimated at 0.1% of the total population (that is, 1 in 1,000). Moreover, no less than 5% of the global population (1 in 20) are estimated to have below average hearing. Furthermore, the figures show that the numbers of deaf and hard of hearing are likely to be lower in developed countries than developing ones, for a variety of reasons including the better health and education services that exist in developed countries (RNID, 2009).

The Royal National Institute for the Deaf (RNID) (2009) has estimated the latest figures for the number of deaf and hard of hearing (DHH) in the UK to be 2.474 million aged between 16 and 60 and 6.471 million aged over 60. This gives a total of 8.945 million across all adults. The RNID (2009) states that the types and causes of deafness are:

1- Conductive and sensorineural hearing loss (mixed hearing loss): conductive hearing loss happens when the sound is blocked in the middle or outer ear. Sensorineural hearing loss happens when hair cells in the cochlear or hearing nerves are damaged.
2- Age: this is one of the most common reasons for hearing loss and such loss is incurable. The RNID (2009) state that "*one in seven people in the UK are deaf or hard of hearing. Most are older people who are gradually losing their hearing as part of the ageing process"* and "*more than 50% of people over the age of 60 have some degree of hearing loss. But only one in three people who could benefit from a hearing aid actually have one*".

3- Noise: this happens when individuals are exposed to long lasting and frequent bouts of loud noise that lead to loss or damage of hearing.
4- Genetics: the RNID state that "*approximately one in 1600 children is born moderately to profoundly deaf because of a genetic cause*".
5- Other ear problems: this includes eardrum damage, wax, trauma and irritation.

The Deaf Action Centre (DAC) (2005) recently published a statistical report on the occurrence of hearing loss in the US. It illustrates that:

1. The rate of hearing loss is higher in men than women.
2. Approximately two to four out of every 1,000 children born in the US are born DHH and nine out of ten of these are born to hearing parents.
3. On an annual basis, the occurrence of sudden deafness in the US is estimated at around 4,000, with only 10-15% of people knowing the cause.
4. Approximately seventeen out of every 1,000 children under the age of eighteen in the US are affected by hearing loss.

This section presents the definitions of deafness, the three models of deafness, and methods that deaf people use to communicate with each other and with hearing persons–bilingual-bicultural, oral or oral–aural and total communication. The second section will discuss the education of the deaf from a historical perspective and the issues surrounding deaf education.

2.1.1. Deaf and Deafness Definitions

In this part, a definition of the terms "deaf" and "hard of hearing", which were introduced by Moores (2001) and IDEA'97 (1997) will be given.

A definition for a deaf person, proposed by Moores (2001) and cited in Carlson, Irons, Rusher, & Gentry (2009), is "*one whose hearing is disabled to an extent that precludes the understanding of speech through the ear alone, with or without the use of hearing aid*". Moreover, the word "deaf" was explained by the United States Congress as a hearing loss which unfavourably influences the individual's educational progress and performance. In

this case, the hearing loss occurs to the point that the individual will be unable to process any form of linguistic information (communication) through hearing (IDEA'97, 2002).

Moores (2001, cited in Carlson et al., 2009), distinguishes deaf from hard of hearing persons (HH) by defining an HH individual as "*one whose hearing is disabled to an extent that makes difficult, but does not precludes, the understanding of speech through the ear alone, with or without the use of hearing aid*". Moreover, the classification of deaf and hard of hearing (DHH) can also be related to the time at which deafness commenced (Moores, 2001). The US Congress defines "hard of hearing" as a loss in hearing that can be either permanent or intermittent, which unfavourably influences the individual's educational progress and performance but, to some degree, allows the individual to access communication with or without amplification (IDEA'97, 2002).

2.1.2. Models of Deafness

There are three main models of deafness that take either the social or the biological perspective (Wordiq, 2010; Power, 2005). Firstly, the medical (or infirmity) model sees deafness as a deplorable condition to be treated and recommends separating disabled students into special schools. Secondly, the social model of deafness sees the design of the deaf person's environment as the greatest disabling factor. Finally, the cultural model is derived from the deaf community, language and culture, resulting in a cultural frame in which deaf people are not categorised as being infirm or disabled.

- *Medical Model*: in this model, society views deaf individuals as people who could be held back as a result of their deafness. Deafness is seen as something that a person would not want, or which makes the person dissimilar in an unacceptable way. Society looks at deafness as a diseased condition that deaf persons suffer from and deafness as a personal problem. It is considered something wrong with the deaf person and consequently their problem. Only professionals can help the deaf person to fit in and be accepted by society. Thus, what alleviates the problem is curing the deafness or making the deaf person seem to be as little disabled as possible.
- *Social model*: in this model society views deaf individuals as being different in the same sense as other differences, such as gender or race. Accordingly, deafness is neither good nor bad but simply part of the identity of the deaf person, which creates special requirement for them to communicate effectively with the rest of society.

Problems come from the deaf person trying to function in an inaccessible society that does not give them the opportunity to communicate effectively. Moreover, the necessary changes to make the society accessible to the deaf could come from the deaf themselves, an advocate, or anyone who wants deaf people to be included equally in the society. Consequently, a change in the society is necessary to make deaf people equal to hearing people. This can be achieved by granting them the accessibility needed to allow them to be involved in the society.

- *Cultural Model*: this model comes from the deaf individuals themselves, consisting of a congenital primary language (sign language), living under the same conditions (being deaf), with others with the same condition and building up social networks among themselves, resulting in naturally evolved groups (deaf social networks) with a minority language (sign language).

In Jordan, the word "deaf" as used in the medical sense is almost always written in lower case (deaf), while in a cultural sense it is almost always capitalised (Deaf). The following Table gives a comparison between the medical and social perspectives:

Table 2.1: Comparison between medical and social models

Medical Model	Social Model
• Deafness is an insufficiency or irregularity. • Being deaf is a problem. • Deafness resides in the human being. • The cure for deafness-related problems is the remedy and normalisation of the individual. • Professionals are the agents of remedy	• Deafness is a difference • Being deaf, in itself, is neutral. • Deafness derives from the interaction between the individual and society. • The cure for deafness-related problems can come from changing the interactions between the society and the deaf person. • The agent of remedy can be anyone who is involved in activities between deaf individuals and the society.

In Jordan, the medical perspective is adopted, with the allocation of ten special schools for the deaf (governmental) and two private ones. These schools are distributed in the major cities but not in rural areas, small cities, or towns. Additionally, the Jordanian society looks at deafness as an illness that the deaf individual suffers from (information gathered during a personal visit to Jordanian schools for the deaf in 2008, 2009 and 2010). However, the

cultural model also occurs in Jordan as there is a close and tightly bended community of the deaf. Many Deaf people get married to each other and have deaf friends. Therefore, the deaf in Jordan have their own language, their own traditions and values, which form a sub-community/culture (Hendriks, 2008).

2.1.3. Communication Methods with the Deaf

This is another important area that is relevant for this research. Various methods have been used, in the past and in the present, for communication with deaf persons. Moores (2001) mentions three main methods: the oral method (lip reading), total communication (oral method plus the use of sign and finger spelling) and the bilingual-bicultural method that uses sign language for live communication (i.e. face-to-face) and language (Arabic, English, etc.) for reading and writing. The following is a brief description of the three methods:

1. The *Bilingual-Bicultural Method*. This method uses sign language for all live communication (face-to-face) and the wider community language (Arabic for the Middle East, English for the UK and USA, etc.) for reading and writing (Kuntze, 1992 cited in Moores 2001). Wilbure (2000) is an advocate of this method, according to him this method support and promote literacy and English for the deaf through the use of ASL.
2. The *Oral Method* or *Oral–aural Method*: deaf pupils express themselves through speech and receive input through reading the spoken words (lip reading), with amplification of the use of the voice by discouraging the use of finger spelling and signs (Moores, 2001).
3. *Total Communication Method*. This method employs a combination of the oral method and sign language (finger spelling and signs). Pupils express themselves and receive communication through speech, finger spelling and signs (Moores, 2001).

In Jordan, deaf pupils use bilingual language (a combination of Jordanian sign language (LIU) and lip reading) communication and Arabic for reading and writing (personal visit to Jordanian school for the deaf, 2008, 2009 and 2010).

In the ICT context, communication method with the deaf can be affected by different factors such as the QOS (Quality of Service) over networks such as LAN's and the internet. This comes from the fact that deaf communications is based on the visual sensory and for example, when deaf people use the total communication method, which is based on oral method and sign language, when communicating through video conferencing over the internet. The speed of connection might affect the quality of the video transmission on both sides (transmitting and receiving). This might lead to a lag during the conversation and affect the bitrate transmission.

2.2. EDUCATION OF THE DEAF

In this part, a historical perspective of educating the deaf is presented from the literature. It shows the main contributions to the field of deaf education. Some of the key issues surrounding deaf education are also addressed.

Mesopotamia (now known as Iraq) and Egypt are considered to have been the first literate and educated societies in history. The first formal education, as it is known nowadays, began there and deafness was first noted there (Moores, 2001). According to Feldman, an Egyptian papyrus from approximately 1550 B.C. holds the first acknowledged reference to deafness (Feldman, 1970, cited in Moores, 2001). However, there is no indication of educational interest towards deaf individuals and attitudes towards the deaf at that time are unknown (Markides, 1982).

Among the Ancient Greeks and later under Roman rule, the circumstances of the deaf worsened. The Greek philosopher, Aristotle has been described as a scoundrel because he defined deaf people as "dumb and deaf". Aristotle thought that deaf people were incapable of being taught and unable to learn or perform reasoned thinking. Influenced by his mentor Plato about deafness, his point of view was that, if individuals could not use their voices similarly to hearing people, then it would be impossible for that person to develop any cognitive skills (Gannon, 1981). Aristotle has been blamed for publicising untruths about deaf people regarding their ability to perform abstract thought and for his view that they were in some way less human than hearing people (Gannon, 1981). Aristotle's assessment

of deaf people's minds is held to be the core root of society's dysfunctional attitudes towards the deaf.

Roman literature mentions only one deaf person (Quintus Pedius), who was educated through the use of painting, being from a noble background (Bender, 1960). Despite this evidence, and possibly other individuals from privileged backgrounds, a person born deaf was generally unable to be educated in Ancient Greece and Rome. However, the lack of education for the deaf in ancient times was not a problem because deaf individuals were still able to make a reasonable living in most societies through the use of other skills (Markides, 1982).

In Western Europe, there is no evidence of any attempts to educate deaf individuals before the sixteenth century. From the time of Quintus Pedius until the fifteenth century, in the Byzantium era, no records of any attempts to educate deaf people have been found (Moores, 2001).

Similarly, and despite the Islamic world being more advanced than other nations between the eighth and twelfths centuries, there is no evidence or indication of any attempts to educate the deaf **(**Moores, 2001**)**. Rhazes (850-923) claimed that deafness from birth is a hopeless case in terms of cure. He divided deafness into three classes: curtailment, impairment, and complete loss; using the Galen theory of hearing (Markides, 1982). This situation, of ignoring the deaf rights in education, continued to exist until the twentieth century.

According to Moores (2001), the beginning of the education of the deaf came in the work of the Italian physician and mathematician, Girolamo Cardano (1501–1576), who argued for the importance of educating the deaf, suggesting that many concepts could be clarified to them with the use of signs. Cardano's point of view was similar to that of supporters of the bilingual approach (Moores, 1990). Moreover, the first teaching of a deaf pupil has been attributed to Pedro Ponce de Leon (1520-1584) in Spain (Markides, 1982; Moores, 2001).

In Great Britain, George Dalgarno (1628-1687) introduced the “The Deaf and Dumb Man’s Tutor”, in 1680 (Moores, 2001). John Wallis (1618-1703) taught the son of the mayor of Northampton, Daniel Whaby, in 1660 (Moores, 2001). According to Gregory (1996), Bulwer (1644) was the first in Britain to introduce the first known document of sign language. William Holder (1616-1698) is considered the first person to have taught deaf students in Great Britain (Moores, 2001). However, according to Moores, Wallis came first in terms of presenting his work. It is also important to note that the first school for the deaf was established in Great Britain by Henry Baker (Moores, 2001).

In France, despite irregular attempts in past centuries, there is no evidence of an efficient effort to help the deaf until Abbé Charles-Michel de l'Epée (1712-1789), founded the first school for the deaf in France, in 1755 (Moores, 2001).At that time, l'Epée succeeded in turning education of the deaf into public concern in France (Bender, 1960). In Germany, Samuel Heinicke (1729-1784) who produced the German method established an alternative attempt to educate deaf people in 1778 (Moores, 2001).

From the above, this indicates that no proof exists of any methodical efforts to instruct deaf individuals earlier than the sixteenth century attempt by Pedro Ponce de Leon in Spain (Moores, 2001). Others, such as Dalgarno of Great Britain, l'Epée and Pereire of France and Heinicke of Germany also contributed to developing an educational foundation for the deaf (Moores, 2001).

Bruce (1973) indicates that over the nineteenth and early twentieth centuries, the two individuals that were the dominant forces in educating the deaf are attributed to Alexander Graham Bell (1847-1922) and Edward Miner Gallaudet (1837-1917) youngest son of Thomas Hopkins Gallaudet at that time.

A study of speech, based on a scientific basis, aimed at improving the methods used to teach the deaf and hard of hearing was carried out by Alexander Graham Bell and his father Alexander Melville Bell (Moores, 2001). In 1868, he introduced visible speech at a private school for the deaf in London (Bender, 1960). In 1871, he went on to teach visible speech at a Boston day school. A year later, he demonstrated his method at the American School and the Clarke School. He established a school in Boston in (1872) (Bender, 1960).

Meanwhile, Thomas Hopkins Gallaudet (1787-1851) co-established the first institution for the deaf in the US in 1817. This school is now called the American School for the Deaf (Moores, 2001).

According to Berke (2009), the year 1880 was exceptional for the deaf people as it was the year that changed their lives and education. In that year the second international congress on education of the deaf took place in Milan-Italy. In that event, sign language was banned and a statement has been made stating that the oral method is superior to the sign language; such an outcome, according to her is due to the fact that Milan conference was prepared by the advocates of oral method (Forshay, 2009).

The outcomes of the Milan conference shifted the main-stream opinion towards the oral method which resulted in the adoption of the oral method as the main method for instruction method for the deaf until the 60s (Forshay, 2009). However, this method resulted in having low literacy achievements among the deaf children who used oral method and been described as the dark age of deaf education (Leeson, 2006; Forshay, 2009).

In the 60s of the last century, the work of William Stokoe proved that ASL (American Sign Language) is language and can be used in educating the deaf people. Stokoe introduced a dictionary of ASL based on linguistic principles; this was considered by many people, such as Lesson (2006), Gregory (1996) and Chotiner-Solano (2005), as the new raising for sign language in deaf education. Stokoe work promoted different aspects of social and intellectual life (Sotkoe,Jr, 2005). The outcome of his work came in the form of presenting the linguistics characteristics of Sign language which led to reconsideration into the human language sciences (Sotkoe,Jr, 2005).

According to Chotiner-Solano (2005) another important event that shifted the education of deaf was the industrial revolution in the United States. This resulted in having immigrants from different backgrounds using their mother tongue next to English, this established the bilingual education. It was applied to deaf education through the use of the sign language and the language of the hearing community (Gregory, 1996). According to Gregory (1996), this method came to be recognised through the work of Stokoe. From this, deaf education

has been subject to continued controversy especially between the manual and oral approaches. This thesis does not focus on the different education and communication options but on the use of ICT in a deaf classroom.

Between the 1960s and today, there have been many improvements made in the education of the deaf, such as the integration and use of ICT to help improve their academic achievements.

One of the main issues in the education of the deaf is learning and teaching. Recently, this has changed significantly. Alongside changes in learning and teaching, the increased use of and improvements to ICT are relevant to many aspects of teaching and learning, in particular mathematics (Watson, 1998).

According to Gregory (1998), teaching mathematics has focused on mathematical attainment and the significant differences in achievements between deaf students and their hearing peers. Gregory summaries the problems facing deaf students in mathematics as being due to the language of mathematics and access to mathematical conversation. He also states that only a small amount of research has been conducted in the area of using sign language for teaching mathematics to the deaf. Gregory states that there are implications concerning the language of mathematics relevant to teaching all deaf pupils. There are additional considerations for those deaf pupils who use spoken language but may think in spatial terms, and further points to consider when teaching pupils who only use sign language.

Gregory concludes that there is a problem with teaching mathematics because the sign language in the area of mathematics is not fully developed. Therefore, sign language should be developed to include mathematical concepts and symbols. Moreover, the complexity of having sign language-based teaching of mathematical concepts is considerable as it requires a large number of different signs. Therefore, teaching mathematics through the use of sign language is considered to be one of the main issues in deaf education (Gregory, 1998).

Another issue in teaching mathematics to the deaf is access to conversations that use mathematical concepts, such as numbers, fractions, size, measurements and time. As an example, hearing people use such mathematical concepts in daily life in asking for the time, for example 'quarter to nine', or talking about distances, such as 'how far is Manchester from here' or 'planet Earth is composed of 71% water and 29% land'. Therefore, according to Gregory (1998), deaf students develop an understanding of mathematical concepts less well than their hearing peers. Deaf students in fact can be confused when dealing with the phonological similarities of numbers such as 23 and 32, or in the case of fractions, when dealing with the numerator and denominator (personal visits to Jordanian school for the deaf, 2008, 2009 and 2010).

Understanding the problem is half solving the problem, going with this analogy, one of the issues Gregory (1998) raises is competence in reading mathematics. Being able to read and understand a mathematical problem is half of the battle towards finding the answer. Being able to understand the problem requires reading competence as a first step. Therefore, it is important, according to Gregory (1998), to "*understand the meaning through understanding the context*".

Another issue in deaf education is the use of ICT. According to Elsendoorn (1998), ICT has massive potential for educating deaf people in different fields, such as mathematics, science and geography. There are ICT design issues that need to be considered in deaf education, however. The first aspect is the deafness issue, which must be considered in terms of interactivity in e-learning environments.

Deaf students usually depend on the visual reception of information and, because of this, they need some visual notification that an interaction is needed with the e-learning environment, or their teacher or peers (in the case of their hearing peers, a sound or beep will do the job). Moreover, it is important when designing e-learning environments for deaf people to consider and define the user groups. Usually, user groups are divided into two or three categories. The categories are students, teachers and administrators, with teachers acting as administrators in some cases. Defining the user groups will determine the use of e-learning, the permissions available for each group and options to be used by each group.

2.3. THE SITUATION FOR THE DEAF IN JORDAN

In this section, a general introduction about Jordan and the country's practices and demography is presented. The second part discusses deafness in Jordan and cultural attitudes toward deafness and deaf people.

2.3.1. Background: Introducing Jordan

Jordan (this is the conventional short form; the local short form is Al Urdun; the conventional long form is The Hashemite Kingdom of Jordan; and the local long form is Al Mamlakah al Urduniyah al Hashimiyah) has witnessed numerous Middle Eastern civilisations and empires through its history, including ancient peoples such as the Canaanites, Semitic peoples such as the Edomites (from Edom), and the Moabites (from Moa'b). Moreover, other civilisations have taken political and economic control and influence over Jordan including the Babylonian, Assyrian, Judean, and Persian empires. Jordan was, for a time, part of Nabatean Empire, which left rich archaeological remains at Petra that are nowadays considered one of the new Seven Wonders of the World. Other cultures and empires outside of what is known today as the Middle East also left their mark, including the Byzantine and Roman Empires.

Since 636 AD, Jordan was part of the Muslim Arab Empire, except for a brief period when the west of Jordan formed part of the Crusader Kingdom of Jerusalem. It was then ruled by the Ottoman Empire. At the beginning of the twentieth century, for a short time, it fell under British rule from April 1921 - May 1946. On 25 May 1946, Jordan (formally Transjordan), gained its independence from the British Empire.

Geographically, Jordan is located in the heart of the region known today as the Middle East, bordered by Iraq to the south-east, Israel and the Palestinian areas to the west, the Kingdom of Saudi Arabia to the south and Syria to the north. Jordan is 89,342 square kilometres in area (34,495.14 square miles) with land making up 88,778 square kilometres (34277.377 square miles) of this (The World Factbook, 2010). In addition, Jordan has access to the eastern side of the Dead Sea, which is the lowest geographical point on Earth, as well as having access to the Red Sea via the port city of Aqaba. Additionally, the majority of Jordan (approximately 78.4%) is made up of desert or semi-desert (Al Badiya)

(Ministry of Education-Jordan, 2008). All major cities are located in the west as the east easts are mostly deserted.

Jordan is an independent sovereign Arab state. Amman is the capital and the Jordanians consider themselves part of the Arab Nation. Arabic is the official language.

"The Hashemite Kingdom of Jordan is an independent sovereign Arab State. It is indivisible and inalienable and no part of it may be ceded. The people of Jordan form a part of the Arab Nation, and its system of government is parliamentary with a hereditary monarchy."
(Constitution of Jordan, Article 1)

"The city of Amman is the capital of the Kingdom, but it may be transferred to another place by a special law."
(Constitution of Jordan, Article 3)

English is used broadly in business, administration and among educated people. English is a compulsory subject at public and private schools in Jordan (Hendriks, 2008). French is an elective subject. As in other Arab countries, Jordanians use two different variations of the Arabic language, the Fus-ha (Standard Arabic, used in all formalities, such as education, the media, and by government officials) and the A'mieh (dialect, used in daily conversation) (Hendriks, 2008).

According to the Jordanian constitution, Islam is the official religion in Jordan. In reality, 92% of Jordanians are Muslims, 6% Christians and 2% have other religions or hold other beliefs (The World Factbook, 2010).

"Islam is the religion of the State and Arabic is its official language."
(Constitution of Jordan, Article 2)

Jordan is considered one of the most advanced countries in the world and the Middle East in terms of personal and religious freedom. This is guaranteed by the Law and the Constitution:

"All Jordanians are equal by law and there is no discrimination among them as far as rights and responsibilities regardless of race, language, or religion."
(Constitution of Jordan, Article 6, paragraph 1)

"Individual freedom is respected."
(Constitution of Jordan, Article 7)

According to the Department of Statistics (DoS), at the end of the year 2009 the population of Jordan was estimated to be approximately 5.98 million citizens and inhabitants (DoS, 2009). The World Factbook (2010) estimates the population in 2010 to be 6.407 million. Moreover, the World Health Organisation (WHO, 2006) has indicated that 70% of the Jordanian population is below the age of thirty.

Various factors have affected Jordan's population, such as the issue of refugees (Hendriks, 2008). More than half of Jordan's population is made up of people with Palestinian origins that are registered as displaced and residing in Jordan or as refugees (The World Factbook, 2010). They have now gained Jordanian citizens. Moreover, since 2003 around 450,000-500,000 Iraqis have fled to Jordan because of the US occupation of Iraq and the Gulf War (UNFPA, 2007). In addition to the Palestinian and Iraqis, there are other nationalities represented, such as Lebanese.

In 2009, Jordan's population of 5.98 million was composed of 3.083 million males (52%) and 2.898 million females (48%) (DoS, 2009). This population is distributed over twelve governorates (see Figure 2.1); these governorates are responsible for all of the government subdivisions and developments in their areas.

Administratively, Jordan is divided into three regions: northern, central and southern. The northern region consists of Irbid, Ajlun, Al Mafraq and Jarash governorates. The central region consists of the capital, Amman, Al Balqa, AzZaraqa' and Madaba governorates. The southern region consists of Al Karak, At Tafilah, Ma'an and Al 'Aqaba governorates.

Jordan has limited natural resources. As a result, the World Bank has ranked Jordan as one of the "lower middle income" countries of the world (World Bank, 2010). However, the country has high rates of literacy and education compared to other countries with similar incomes (World Bank, 2010; Hendriks, 2008). Jordan's population growth rate in 2009 has been estimated at 2.26% with a rank of 42 worldwide, less than the 2008 population growth rate of 2.34% which ranked Jordan as 43rd in the world (The World Factbook, 2010).

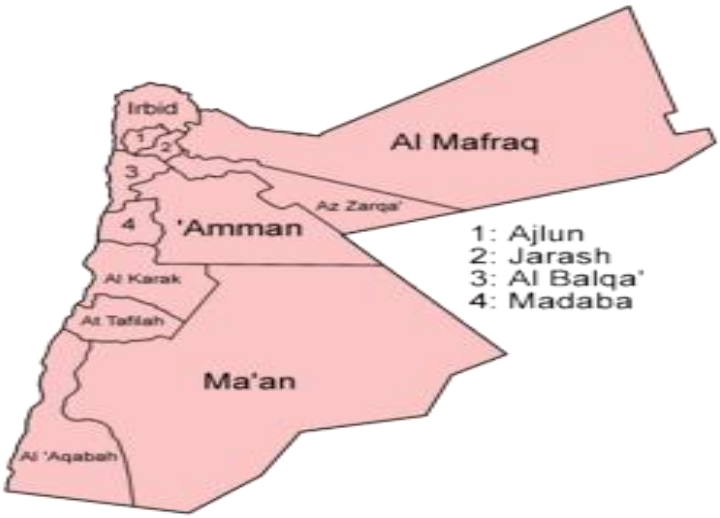


Figure 2. 1: Jordan Map from (Arab News Blog, 2010)

2.3.2. Deafness in Jordan

The most recent census of deaf individuals in Jordan took place in 2004 and showed that there were a total of 9,914 deaf Jordanian individuals, which represented about 0.19% of the total population of Jordan in 2004, and of which 57% (5,612) were male and 43% (4,302) female (see Table 2.3) (DoS, 2009). However, the total number of deaf people in Jordan is 10,310 (DoS, 2009). Therefore, it is presumed that deaf numbers in Jordan have increased since 2004 to around 11,500–13,000, based on the average population growth rate of 2.5%. Such figures apparently include people who have age-related hearing loss and those who were born with impaired hearing or lost their hearing during childhood. However, Hendriks (2008) has estimated that there are 15,000–20,000 people with mild to profound hearing loss in Jordan and concluded that such numbers are similar to those in the Netherlands.

According to Hendriks (2008), the deafness rate in the Arab region is much higher than in western countries, due to genetic deafness caused by consanguineous marriages. Al-Zraigat states that hearing impairment is the second most common disability in Jordan (Al-Zraigat, 2002 cited in Hendriks, 2008). In Jordan, little research has been conducted into deafness (Abu Shaira (2008) and Hendriks (2008). Hendriks indicates the need to carry out more research into the genetic of deafness.

In the first epidemiological study in Jordan, which was conducted by the Ministry of Health (MOH) in 2007, a total of 5,423 subjects were tested from eight governorates, 2,385 of whom (44%) were male and 3,038 (56%) female (Kharabsheh, Alouzi, & Asa'ad, 2007). The study was carried out to identify the prevalence and main causes of hearing disorders, which is important information for decision makers to set a plan of action for the identification, prevention and interaction with the problem.

In 2007, Jordan joined the Convention on the Rights of Persons with Disabilities (CRPD) as part of its efforts to help disabled people (United Nations, 2007). As a consequence of that convention, Jordan has issued a law on the rights of persons with disabilities (Law Number 31 for the year 2007). The outcome of that law was a public, financially, and administratively independent council named the Higher Council for the Affairs of Persons with Disability (HCAPD). The law emphasise promoting all aspects of the lives of disabled persons in Jordan, under the supervision of HCAPD. The law that has been put into action via a strategic plan started in 2007 and is planned to continue until 2015, based on a national strategy for disabled people (HCAPD, 2009b).

The Jordanian government has ensured equal work opportunities for disabled citizens. According to Law Number 31 for the year 2007, Article (4) Section (C): Vocational Training and Labour:

"Enabling persons with disabilities to obtain equal opportunities in the field of work and employability in accordance with their educational qualifications"

"Obligating public and private sector institutions and companies employing not less than 25 workers and not more than 50 to employ one person with disability. If the number of workers in any of these establishments exceeds 50, disabled workers should account for not less than 4% of the work force provided that the nature of the work allows this provision"

"The employer shall provide reasonable accommodation necessary"

"Providing persons with disabilities with appropriate vocational training as well as developing their capabilities according to the requirements of the labour market, including training trainers working in this field and rehabilitating them"

The national strategy for disabled people emphasise promoting services such as health, basic education, higher education, vocational training and labour, social protection and

institutional care, environmental access, custom and tax exemptions, public and political life, sport, culture, recreation and litigation for the disabled (HCAPD, 2009b).

In 2009, the HCAPD set up a multi-dimensional plan to help disabled people and promote services. One of the planned projects is aimed at reaching rural areas in all regions and governorates, monitoring programmes for the disabled, expanding their offices and many other goals. Another project is the creation of a national database containing the numbers of disabled people, institutions providing services for them and the nature and quality of the services provided to them (HCAPD, 2009a). Table 2.2 illustrate the deaf person distribution in Jordan in 2004.

Table 2.2: The distribution of Jordanian deaf persons by age, sex and governorate in 2004

Region/Governorate	Male	Female	Total	Total (%)
Amman	1895	1453	3348	56.84211
Al Balqa	350	236	586	9.949066
AzZaraqa’	964	752	1716	29.13413
Madaba	122	118	240	4.074703
Central Region Total	3331	2559	5890	59.44091
Irbid	1105	798	1903	60.47029
Al Mafraq	321	249	570	18.11249
Jarash	205	137	342	10.86749
Ajlun	170	162	332	10.54973
Northern Region Total	1801	1346	3142	31.70855
Al Karak	206	148	354	40.36488
At Tafilah	55	59	114	12.99886
Ma’an	124	114	238	27.13797
Al ‘Aqaba	95	76	171	19.49829
Southern Region Total	480	397	877	8.85054
Kingdom Total	5612	4302	9914	100.0

2.3.3. Cultural Attitudes towards Deafness in Jordan

Islamic teaching focuses on the equal treatment of humans regardless of race, gender and colour. There is a well-known story in Islamic history in which a Quran Sura is revealed by the Prophet Mohammed (pbuh), the story starts when the Prophet Mohammed (pbuh) turns his back on a blind man who comes asking for advice and knowledge from him. Afterwards, God reprimands Mohammed (pbuh) for this, as is mentioned in The Holy Quran Sura 80 ('Abasa) Verses 1-5 (Ali, 2002).

Despite Islamic teaching, disability (and deafness as one aspect of it) is considered and seen as a disgrace in the Arabic culture and disabled people are treated in a bad way. As a matter of fact, the latest horrible crime committed lately in Jordan (2011) against a 19 year old mental handicapped girl. Her family hid her for 19 years in a stable and never showed her to public until she passed away.

Deafness is considered to be a tribulation or tragedy for the disabled person and his family. Arabs consider the occurrence of a disability in their life (in a family member or themselves) as a test from God of their faith and believe that they should submit to and accept God's will (Turmusani, 1999b and Hendriks, 2008). Although some types of disability are considered a tragedy by Arabs, Al-Zraigat (2002) mentions that society in Jordan considers disabled individuals as special and gifted from God, in terms of spirituality. In other words, disabled people are thought to be bringers of happiness and grace in life and after life. However, in real life, having a disabled person in the family is thought to be highly undesirable and possibly even shameful. Families with disabled members used to hide them from other people as they feared it may prevent other families from marrying their hearing offspring (Hendriks, 2008). Moreover, families with disabled members would often seek medical treatment using mythological methods (Al-Zraigat, 2002 cited in Hendriks, 2008). Such conditions have prevented the disabled from gaining education, marriage or work.

Over the past forty to fifty years, this attitude has changed (Turmusani, 1999b). This happened because of international agencies becoming active in Jordan in the early 1960s (Hendriks, 2008 and Turmusani, 1999a), and the increased rate of education and literacy, that resulted in increased awareness of disability. Such awareness urged the government to create a special agenda for disability (Hendriks, 2008). Since then, social and sport clubs for the deaf were established (the first in 1986) with the cooperation of the Ministry of Youth (which has since been replaced by the Higher Council of Youth and Sport) and which aimed to integrate deaf and hearing impaired people into society and provide them with careers and interpreting services (Hendriks, 2008).

2.4. EDUCATION IN JORDAN

Jordan has put an emphasis on providing education to all its citizens. All Jordanians have the right to education, guaranteed to them by the government and protected by the constitution.

"The government guarantees work and education for all within its capabilities. Also, it guarantees security and equal opportunities for all Jordanians."
(Constitution of Jordan, Article 6, paragraph 2)

According to the International Human Development Indicators (2010), Jordan has maintained steady levels of expenditure on human development (up to 25% of GDP) over the past thirty years. This development focuses on education, health and pensions and social safety nets. This ranks Jordan above average in comparison to other countries with similar economic rankings (World Bank, 2010). This has been reflected in the comprehensive modernisation programme launched by the government in 2003, which aimed to renovate the educational system to meet the needs of a knowledge-based economy (World Bank, 2010). The latest statistical records, in 2007, showed that the distributions of educational levels in Jordan by sex are as follows:

Table 2. 3: Distribution of Jordanians aged 15+ by educational level and sex (DOS, 2009)

Educational Level	Male (%)	Female (%)	Total (%)
Illiterate	4.3	11.6	7.9
Less than Secondary School	56.4	48.0	52.2
Secondary School	18.1	19.5	18.8
Intermediate Diploma	6.6	10.2	8.4
Bachelors and above	14.6	10.7	12.7
Total	100	100	100

The Jordanian government took a radical step towards meeting modern market demands by enabling labour force adaptation to the market needs. This step made Jordan among the highest spending countries in the Arab world on education; it invested more than 20.4% of its GDP on education in 2009 (Jordan Investment Board (JIB), 2009). As a result, the literacy rate in Jordan has reached more than 91%, which is considered one of the highest in the Middle East (Jordan Investment Board (JIB), 2009 and UNICEF, 2007).

2.4.1. Education Structure in Jordan

The Jordanian education system consists of the following stages: kindergarten, basic education, secondary education roots (academic, vocational and applied), general secondary education examination certificate, and either university or community college (see figure 2.2).

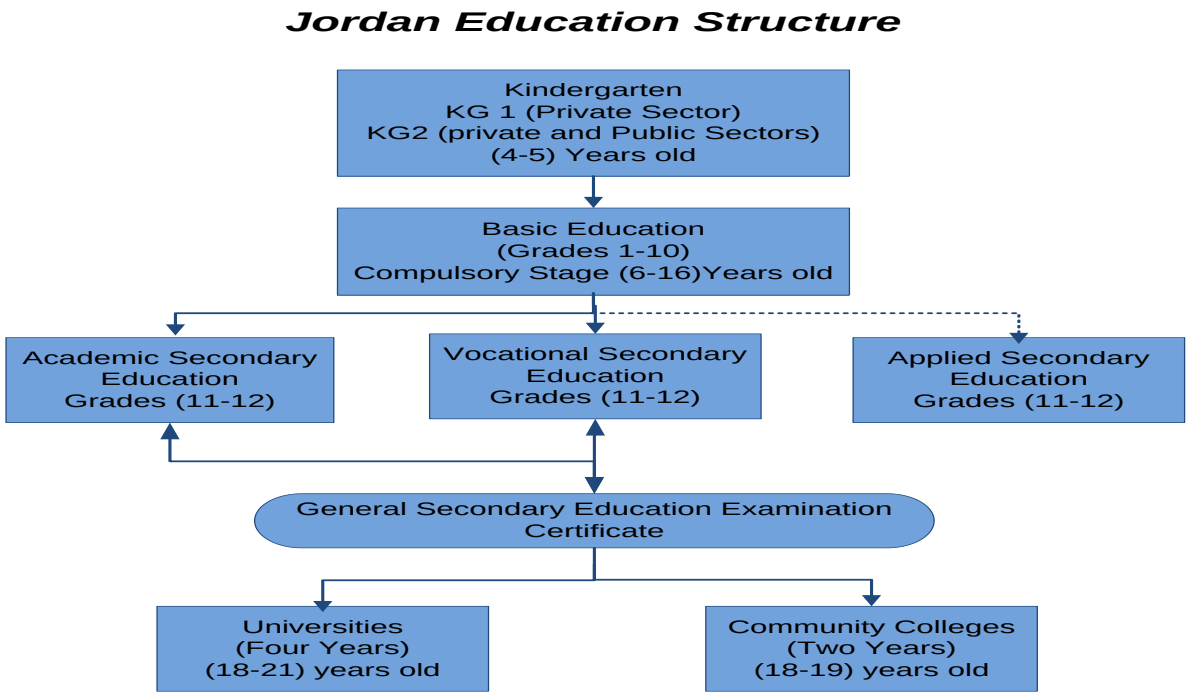


Figure 2.2: The Jordanian education system, from the MOE (2008)

2.4.1.1. Kindergarten, Basic and Secondary Education

School education in Jordan consists of two years of kindergarten (pre-school), ten years of basic education (primary and middle schools), which is compulsory and free for all Jordanians, and secondary schools (eleventh and twelfth grades). Although secondary education is optional, the secondary stream is determined by the accumulated scores from grades eight, nine and ten, obtained during basic education.

At the end of the secondary stream, further education is determined by the student's results in the General Secondary Education Examination, which is a national exam (Tawjihi or Thanawaia al 'amah). Passing and gaining a certificate in that exam entitles the student to carry on their undergraduate studies at university or community college.

According to the statistics of the Ministry of Education (MOE) for the academic year 2007-2008, there were 5,690 schools in Jordan. The private sector owned 39% of these schools, 57% were run by the MOE (government schools), the United Nations Relief and Works Agency (UNWRA) ran 3% and 1% were under the management of other government authorities (MOE Statistics, 2009). In 2004-2005 19.2% of the schools were in the private sector, 70.5% run by the MOE, 8.9% by UNWRA and 1.4% by other government authorities (Al Jabery & Zumberg, 2008).

The same source shows that in 2007-2008, there were 89,512 teachers, 35% of who are male and 65% female (MOE-Jordan, 2009). The number of students was estimated to be 1,598,211, with an almost equal representation of 50.5% males and 49.5% females (MOE, Jordan, 2009). The distribution of teachers and students by school authority is given in Table 2.4 below.

Table 2. 4: Distribution of teachers and students in Jordan by authority, in the year, 2007-2008

Authority of school/ Numbers	MOE	Private Sector	UNWRA	Other government Authorities
Teachers	70.%	24%	5%	1%
Students	69 %	22%	8%	1%

2.4.1.2. Higher Education in Jordan

The implementation of Jordan's development plans required qualified, technical and well-trained manpower, especially for Higher Education (HE). This has been reflected in the number of HE institutions that are distributed all over the country (urban and rural areas) (MOE-Jordan, 2009).

In the second half of the twentieth century, HE began in the form of Teachers' Colleges throughout the country to meet the high demand for school education through providing the necessary teaching manpower (Abu-El-Haija, 2005).

The first formal HE institution in Jordan was Jordan University (Jame'a Al Uordoniya), established in 1961-1962 (Jordan University, 2009). Since then, the number of HE institutions has increased to 29 universities and sixty community colleges. All HE

institutions fall under the supervision of the Ministry of Higher Education (MOHE). Moreover, the Jordanian government has opened the door for private sector participation in Jordanian HE. This step has led to sixteen of the 29 universities in Jordan being privately owned (MOHE-Jordan, 2010).

According to MOHE's 2008/2009 statistics, there were 219,277 students enrolled (returning) in Jordanian universities and studying for a BA or BSc (undergraduate level), of whom 49.1% (107,732) were male and 50.9% (111,545) female, an almost equal representation. A further 51,131 students were admitted to Jordanian universities in that year, of whom 51% (26,125) were male and 49% (25,006) female (MOHE-Jordan, 2009).

At the graduate (postgraduate) level, there were 17,543 students, 45.8% (8,025) female and 54.2% (9,518) male. 30,061 students were enrolled in community colleges for the year 2008/2009, 42.2 % (12,684) male and 57.8% (17,377) female (MOHE-Jordan, 2009). However, there is no indication of the numbers of deaf students at either the graduate or undergraduate level.

2.4.2. An Overview of Special Needs Education in Jordan

There is a rapidly growing interest among all countries of the world to enhance and improve their educational systems to meet the needs of students with special needs (deaf people among them) and provide them with proper educational services. Such services could be provided through up-to-date educational practices and methods designed to meet the abilities of students with special needs and respond to their needs.

In Jordan, there was a need to change the educational philosophy away from the conventional idea of focusing on the educational system and insisting that learners should adapt themselves to it and towards adapting the educational system to fulfil the learners' needs. As have many other countries, Jordan has enacted legislations and laws to enhance educational services for people with special needs.

Jordanian education services are provided to disabled people (and deaf people among them) without regard for their age or disability. There are 144 institutions and centres scattered throughout the country, providing services such as welfare and rehabilitation to disabled

individuals. These centres and institutions fall under the supervision of the MOSD, the MOE, the private sector or UNWRA (UNISCO, 2004).

The Jordanian government has sanctioned human rights acts, eradicated all sorts of discrimination and prejudice among citizens and given much attention to integrating people with special needs into other groups. The government is represented by both the Social Development and Education Ministries and other national and international parties which have joined efforts to accommodate, educate and train those with special needs through special programmes aimed at integrating them into the community. Moreover, a national strategy was adopted in 2007 to promote the services provided for them (MOE, Jordan, 2008). The Law on the Rights of Persons with Disabilities (Law Number 31, 2007) in Article (4) Section (B) emphasise:

"Providing persons with disabilities with general, vocational and higher education opportunities in accordance with their disability category through integration."

"Adopting inclusive education programs between student with disabilities and non-disabled counterparts and implementing these programs within the framework of educational institutions."

"Making available reasonable accommodation that assist people with disabilities to learn, communicate, receive training and enjoy mobility. Such tools should include Braille methods, sign language for the deaf and other necessary equipment and tools."

"Carrying out educational diagnosis within overall comprehensive digenesis team to determine the nature of disability, its degree and requirement."

"Carrying out guidance, awareness, and orientation programs for students with disabilities and their families."

"Providing modern techniques for educating students with disabilities in the public and private sectors, including teaching mathematics and computer skills."

"Admitting students with disabilities who pass the General Secondary Studies Examination to public universities, in accordance with conditions to be agreed upon between the HCAPD and the Council of Higher Education."

"Making available methods of communication for persons with hearing disabilities, including sign translation."

2.4.3. Deaf Education in Jordan

The first educational establishment for the deaf in Jordan was the Holy Land Institute for the Deaf (HLID), established by the Anglican Church in 1964. The HLID is considered the only educational institute that provides residential services to the deaf in Jordan. Moreover, it is the leading and model institute in the Arabic world for deaf education, sign language and implementation. The HLID provides services to 150 deaf students, 41 in secondary education (Tawjihi). It also provides educational services at kindergarten, and basic (primary and middle) levels (Hendriks, 2008). Moreover, it founded the Salt Training and Resource Institute for Disability, Etc. (STRIDE) to improve or enable deaf education in other countries, including Syria, Yemen, Iraq, and Egypt.

The party responsible for providing educational services for the deaf is the MOE, which took over from the MOSD, previously responsible for providing education and rehabilitation services. The first governmental educational institute for the deaf in Jordan was established in Amman in 1969 by the MOSD under the name of Al Amal (The Hope). By the year 2007, the total number of government schools for the deaf in Jordan had reached ten, distributed through the major cities, and the authority for these schools has transferred to the MOE (personal Visit to MOE in 2009). In addition to these schools, the MOE has introduced classes for the deaf in some of the mainstream schools. According to Hendriks (2008), there are around 400-500 such classes and the deaf students who attend them number 450-550.

Table 2. 5: Deaf schools in Jordan by location, student and teacher numbers, grades, year of establishment and administrative authority (MoE, 2007-2008)

School Name	Location	Students	Teachers	Grades	Authority	Established
Alaml School	Amman	190	26	KG–7th	MOE	1969
Alhemsy	Amman	29	6	KG–3rd	MOE	1990
Alaml School	Amman	195	28	KG–7th	MOE	1978
Alaml School	Irbid	117	19	KG–7th	MOE	1997
Alrabah	Aqaba	44	17	KG-12th	MOE	1993
Alaml School	Alkarak	43	17	KG–7th	MOE	2002
Alaml School	Tafilah	24	10	1st–7th	MOE	1994
Alaml School	Zaraqah	85	6	KG–3rd	MOE	1993
Alkorrah School	Irbid	37	12	KG–3rd	MOE	1991
Alaml School	Madaba	35	6	1st – 7th	MOE	2007
HLID	Balqa	150	35	KG–12th	Private	1964
Al-Raja	Zaraqah	50	N/A	KG–12th	Private	1977

Until 2006, basic (primary) education was offered to deaf pupils (up to the 6th grade, approximately 12 years old) in governmental schools. There was then an interest in expanding this to include classes up to secondary level (9th grade), but is still less than the compulsory education provided to hearing students. This does not allow deaf students to attend Higher Education. Despite the aim of making all schools provide secondary education in the future, the only governmental school in Jordan that currently offers this level of education to deaf students is in the city of Aqaba.

In 2004, there were approximately 4,522 deaf children between the ages of five and nineteen years (kindergarten to secondary education level), of whom 57.6% (2,603) were male and 42.4% (1,919) female (DoS, 2004). This made up 45.6% of the total Jordanian deaf population. Estimating the numbers four years on, in 2008, gives the following:

Table 2. 6: Deaf numbers (aged 5-19) in 2004 (DOS figures) and estimated numbers for 2008

Age/Year	1-4	5-9	10-14	15-19	20-24	Age > 25
2004	625	1662	1589	1271	977	3777
2008	N/A	625	1662	1589	1271	4754
Total 2008	N/A	3876			1271	4754

By eliminating other factors that affect the population, such as death, travelling abroad with parents, etc, it was estimated that there would be a total number of 3,876 deaf people of school age, of whom 57.8% (2,238) would be male and 42.2% (1,638) female, by 2008.

Hendriks (2008) states that in 2008, 850 deaf students were attending schools for the deaf and a further 450-550 were attending classes for the deaf in mainstream schools giving a total of 1,300-1400 deaf students attending schools.

The total number of students attending the twelve schools for the deaf is 999 in 2009-2010. Therefore, counting this number to the numbers of the deaf who attend mainstream schools will result in having approximately 1,450-1,550. Comparing the figures in Table 2.6 to those in Table2.7, there are approximately 3,876 school age deaf pupils (five to nineteen years) and the school attendance numbers are approximately 1,450-1,550. This means that the school-age deaf Jordanians who were actually attending school in 2008 was between 37.4% and 39.9%.

Thus, despite the efforts of the Jordanian government, the private sector and NGOs, 60 % of Jordanian deaf of school age are still not receiving education. In addition, there are a lot of problems in the Jordanian schools for the deaf, such as a lack of services and insufficient provision of supporting elements and infrastructure (personal visits to Jordanian schools for the deaf, 2008, 2009 and 2010).

The latest census of the number of educated deaf people (over fifteen years old) in Jordan was taken in 2004. It showed that there were a total of 6,014 deaf people, of whom 55.8% (3,356) were male and 44.2% (2,655) female.

Table 2. 7: Educated deaf persons in 2004

Educational Level	Number of deaf persons
Illiterate	2442
Read & Write	466
Basic Education (Preparatory & Elementary)	2423
Vocational Apprenticeship	101
Secondary	412
Intermediate Diploma	99
Bachelors (BA, BSc)	58
Higher Diploma	2
Masters (MA, MSc)	7
PhD	1

From this, it is clear that the total number of deaf persons above the age of fifteen with a HE degree was 167, about 2.7% of the over-fifteen deaf population. A general school certificate was achieved by 2,936, representing 48.8% of the total. Finally, the literacy rate among deaf persons aged over fifteen in Jordan is shown to be 59.2%, while the literacy rate among the total deaf population (all ages) was 35.9% in 2004.

The Jordan Jubilee, states that 50.1% of the population in Jordan in 2001 is under 19 (the Jordan jubilee, 2010). Using the 2008 figure for the number of deaf people in Jordan, which was estimated by Hendriks (2008) to be about 15,000, as a starting point and assuming that 50.1% are under nineteen years of age, this gives a figure of 7,000 deaf people under the age of nineteen. Between 1,450 and 1,550 of these are estimated to be attending school and the rest are not. Therefore, it seems that most of the deaf people in Jordan are engaged in manual labour such as car maintenance, carpentry or factory work (Hendriks, 2008).

According to Hendriks (2008) approximately 35-40 deaf students were enrolled in Higher Education (Universities and Community colleges). In the last five years, only three universities in Jordan have provided services for the deaf, such as interpreters and sign language support, despite the fact that under the agreement between the MOE and the universities, they should provide an interpreter for every two deaf students (Hendriks, 2008). During a visit to Mu'tah University to observe two second-year female deaf students studying special education, it was found that, as Mu'tah University is not one of the universities that provides services for the deaf, the mother of one of the students was acting as the interpreter.

According to Hendriks (2008), most deaf students in HE in Jordan are studying special education with the aim of teaching their counterparts in schools, although some deaf people are studying other subjects, such as general education, physical education (sports), physiotherapy and architecture. Others are studying similar subjects and courses at community colleges. While visiting the HLID in the city of Salt during this study, it was noted that the computer teacher there was a deaf graduate of the HLID who had gone on to community college and earned a diploma in computer science.

In Jordan, an enormous effort has been made to educate the deaf through providing a reasonable level of education and special services. These efforts have earned Jordan a high ranking in terms of educating the deaf within the Middle East. Jordan is the only country in the Arab region where the deaf can continue their education at higher levels (community colleges and universities), with the aid of university staff interpreters. Jordanian deaf education, however, is still in need of a vast number of improvements in different aspects, such as infrastructure, tools and materials, as stated by Al-Zraigat (2002 cited in Hendriks, 2008). Moreover, the teachers are often unprepared for teaching the deaf as they come from regular schools or from other areas of special education, such as for the visually impaired, physical, mental or multiple handicaps. Additionally, most of the teachers who work with the deaf initially lack knowledge of Jordanian sign language (JSL or LIU) (Hendriks, 2008).

Deaf and deaf education situation in Jordan can be summarised in the following:

- The most recent survey of deaf individuals took place in 2004, this gives an indication about the later attention been given the deaf in Jordan.

- The deafness rate in Jordan is similar to other Arab countries; however, this rate is much higher compared to the western countries, due to genetic causes (Al-Zraigat, 2002 cited in Hendriks, 2008).
- According to Abu Sharia (2008) and Hendriks (2008) little research has been conducted in the Jordanian context regarding deafness and deaf education.
- In recent history, there has been no attempt to educate deaf in Jordan before 1964. This indicates that there was no prior consideration given to the deaf and their education. This includes research and studies of deafness. Moreover, this indicates that the Jordan government has never paid any attention to the deaf in Jordan. Presently only ten schools scattered all over Jordan and in the main cites and most of them do not offer secondary level.
- Nearly more than 60% of deaf at school age in Jordan does not attend education.
- There is no formalised educational structure and syllabus for the deaf in Jordan. There is very little support and provision for the deaf education in Jordan. In Middle East in general and in Jordan particular very little research work has been carried out with only a few empirical studies available in the open literature. The use of e-learning systems will have a significant impact on helping deaf with education in Jordan as well as the Middle East in general.

2.4.4. ICT and E-Learning in Jordan

With the rapid growth and development of ICTs in many areas in our lives, the usability of this huge resource for communication is essential, particularly for transferring data, such as text, images, video/audio files and animations.

The Middle East and North African countries (Jordan among them) have witnessed many problems in their recent history. These include political, economic and social problems (Arab Knowledge Report, 2009). These have affected the development of the educational sector. Jordan is not immune and has been affected significantly by political, financial and economic problems.

His Majesty King Abdullah II had a vision to incorporate fundamental knowledge and skills within the education system in Jordan. The aim was for Jordan to become an

international technology hub within the Middle East. Such a vision requires a comprehensive scheme of arrangements and preparation, using the latest available technologies, gaining benefits from worldwide best practices and adopting scientific methods (MOE-Jordan, 2004).

"By empowering our youth through this education initiative, Jordan and its World Economic Forum partners can create a dynamic and practical model of public-private partnership in the area of ICT that can ignite the engines of growth for future generations in Jordan and the region."

H.M. King Abdullah**,** King of the Hashemite Kingdom of Jordan, from (World Economic Forum, 2007)

Many countries use an economic development rationale to explain the planned use of ICT in schools, these countries include the US, Singapore, Ireland and Jordan, among others. Jordan's ICT-based reform effort was to make the education sector "*responsive to employment market demands in key industries and develop critical 'Knowledge Economy skills' at all levels of the education system*" (Kozma, 2007).

The MOE has realised the importance of focusing on human capital development factors so as to be in line with future knowledge-based world economies. The Government of Jordan placed this among its highest priorities. This was reinforced by His Majesty's presence and active participation in Education and high-profile ICT Forums (MOE-Jordan, 2008).

The use and adaptation of ICT in Jordan has witnessed several stages. In 1983, the Council of Education at the MOE sanctioned the teaching of computing in secondary schools as an experimental step towards the adoption of ICT in schools and offered this on a voluntary basis to all students who wished to participate.

From 1984 to 1985, 22 computers (Apple Macintosh) were distributed two schools in Amman (one school for females and one for males). In 1986-1987, 22 schools joined the project with each of the schools receiving only one computer each due to financial circumstances. In 1987, the outcome of the Promoting Education conference, held in Amman, emphasised the use of ICT in learning, and the use of ICT and computers in schools to manage learning and learners (school management).

Between 1987 and 1991, the number of schools using ICT and computers on their premises reached 220 and two years later, a further 101 schools were added. By 1994, 321 schools, with a ratio of one PC to four students, were involved. Since then, the MOE has continued to work towards the integration of ICT and computers into mainstream schools across Jordan. In the academic year of 2000-2001, English language was taught through ICT and computers starting from the 1st grade and computing was made a compulsory subject (Personal visit to the MOE-Jordan, 2009).

The MOE has also invested in ICT and e-learning by launching training programmes for teachers and staff, such as ICDL, Cisco networking, A+, MCAD (Visual Basic.net), and the Intel initiative training programme (personal visit to the MOE-Jordan, 2009). In 1999, the MOE started to collaborate with the New Brunswick Department of Education in Canada. This collaboration resulted in it integrating ICT into its school system (New Brunswick, 2008).

In 2003, the Jordanian government initiated the Education Reform for the Knowledge Economy (ERFKE) programme, as an effort to transform the education system. Additionally, in the same year, the Jordan Education Initiative (JEI) was initiated with the support and assistance of the World Economic Forum (WEF), aimed at developing ICT implantations in Jordanian schools (United States Agency for International Development, 2008).

The MOE has been working with the JEI, a public-private partnership (PPP) with leading information technology and communications firms, to enhance the use of information technology (IT) and establish models for e-learning in Jordan (Method, 2008). One of the JEI's major aims is Teacher Training. It has trained around 3,000 teachers on how to make use of computers for teaching, through: ICDL, Intel Teach to the Future, CADER, World Links programmes, and Subject Specific Training (SST) (Bannayan, 2007).

According to the Internet World Stats (2010) for the Middle East, internet user numbers in the year 2000 was 127,300. However, on June 30, 2010, Jordan had an Internet usage (the number of users of the Internet) figure of 1,741,900 representing 27.2% of the population (penetration).

According to the Director of ICT and e-learning at the MOE, they will continue the reform of the educational system, with an emphasis on the incorporation of ICT, effective long-term usage of ICT in e-learning and, eventually, a sustainable infrastructure for life-long learning. Skills of the future are regarded to be critical and creative thinking, problem solving and orientation towards research and these will be integrated into its ICT and training programmes, rendering a richer and wider spectrum of benefits at all levels of the educational hierarchy.

2.4. SUMMARY

This chapter has presented the definitions of deaf and deafness, has described the medical, social and cultural models of deafness, demonstrated the differences between them and the model which has been adopted in Jordan. Communication methods of/with deaf individuals were also presented. In the second part, a history of the education of deaf people throughout the world was given and some issues surrounding deaf education were presented. In the third part, the situation for the deaf in Jordan was presented, starting with an introduction to Jordan as a country and going on to provide the latest available statistical information about the deaf and their education in Jordan. The next part introduced the educational sector in Jordan and described the Jordanian government's efforts towards providing education for those with special needs, and the deaf in particular. This chapter has also described the religious and cultural attitudes towards deaf people in Jordan. Finally, this chapter has given an overview of the Jordanian government's efforts towards the integration and implantation of ICT tools and e-learning within the country's educational system.

The next chapter of this thesis will show and discuss the literature into the terminologies of learning, education, training and learning theories; educational technologies, e-learning and LMS; e-learning and deafness and other related projects.

CHAPTER 3

LEARNING, E-LEARNING AND DEAFNESS

3.1. INTRODUCTION

From a historical point of view, the use of available technologies in education is relatively old. The technology applied to education must be seen in reference to its availability at the time. Since the mid-twentieth century, educators and researchers have been investigating the implementation of available technology in disabled education (including deaf education) and training. However, the delivery of education has been transformed since then and is still being transformed in unthinkable ways (DeNeui & Dodge, 2006).

In the last few years, the impact and influence of technology can be seen and a huge amount of interest in e-learning has been witnessed; politicians hope its potential will improve the quality of citizens' lives, while economists, industry experts, and academics all hope it will revive their respective fields (Dagada & Jakovljevic, 2004). Moreover, since e-learning was introduced into the business sector, firms have made major investments to support such initiatives. Chell's (2001) economic development review showed that approximately 20% of today's available workforce has the skills required for 60% of the new jobs of the early 21st century. As a result of this, enterprises and firms have invested in e-learning with the aim of improving earnings, enhancing workforce productivity and increasing firm revenue.

Before investigating the use and implementation of e-learning and LMS's in deaf education in Jordan, it is necessary to provide a review of the development of each part of this research: (a) terminologies of learning, education, training and learning theories; (b) educational technologies, e-learning and LMS; and (c) deaf learning and education, other similar projects and the gap in knowledge this research aims to fill in Jordan.

In this context, the researcher limits the scope of e-learning to *deaf education at the primary level within the Jordanian context.* This means that e-learning in any other

discipline, such as business, secondary education or higher education, although of interest, is outside the scope this study.

First of all, an overview of the various definitions and background of learning, learning theories, education and training will be provided. It addition, a review of the current practice of the various types of e-learning is offered and a look at the impact of learning theories on designing e-learning is provided.

3.2. LEARNING AND LEARNING THEORIES

As mentioned above it is very important to begin by providing a review of terms related to learning, such as education and training. In the literature, the terms "education" and "training" have received a considerable amount of attention, in terms of both their definition and practice. Later in this section, learning theories and their implications for e-learning are discussed.

3.2.1. Learning

The Naukri Hub (2007) describes training as a learning process. This process involves gaining knowledge, improving the skills that may lead to a change in attitudes and learning behaviours that will enhance the performance of a particular learner. Training has been described by Elkington (2000) as a change in level of various skills. Elkington draws a distinction between training and education, with education being a change of knowledge and training a change of skills.

Given Elkington's (2000) definition of education as a change of knowledge, the word "knowledge" needs to be defined. However, in the field of epistemology, the definition of knowledge is a matter of on-going dispute among theorists. The Oxford English Dictionary (2009) defines knowledge in a general sense as "*the fact or condition of being instructed, or of having information acquired by study or research; acquaintance with ascertained truths, facts, or principles; information acquired by study*".

According to Newman (1999), knowledge is information that is used in a productive way. Similarly, Rosenberg (2001) refers to it as well-structured information. Despite the on-

going debate among theorists over the definition of knowledge, Davenport (1997) describes it as valuable information coming from the human mind. Knowledge is described, by Davenport and Prusak (1998), as experiences, values, insights and contextual information.

On the other hand, others such as Tobin (2000) describe knowledge as used and tested information. It has one of the four stages of learning, which are data (stage 1: plain facts), information (stage 2: processed, organised, structured or presented data), knowledge (stage 3: used and tested information) and wisdom (final stage: applying knowledge to gain experience). Figure 3.1 is adapted from Tobin (2000):

Figure 3. 1: Four stages of learning adapted from Tobin (2000, p.10)

From the above, it can be seen that there is a general agreement over the information part of the definition of knowledge with a distinction between knowledge and information. However, there are some issues with Tobin's four stages of learning. Firstly, the figure suggests that the relationship between data, information, knowledge and wisdom is a linear one. Despite the fact that there is nothing to suggest that Tobin's model should be linear, the model implies a symmetrical relationship among the four entities, with the directions of such relationships being irreversible, that is, wisdom does not lead to knowledge, knowledge does not lead to information and information does not lead to data. Obviously, what Tobin proposes is incorrect, as in different circumstances we will often use our knowledge to obtain information and to assemble data.

According to Edvinsson and Malone (1997), there are two types of knowledge, tacit and explicit. Raelin (1997) and Weggeman (1997) agree that tacit knowledge is impossible or difficult to transmit. Nonaka and Takeuchi (1995, p.59-60) describe tacit knowledge as

"*personal, context-specific, and therefore hard to formalize and communicate"* and explicit knowledge as "*knowledge that is transmittable in formal, systematic language*".

On the other hand, in his book titled 'Designing e-Learning', Carliner (2002, p.7) defines tacit knowledge as *"content that exists within an individual or organization but has not yet been recorded or exchanged"*. This implies that such knowledge is transferable but needs to be organised and managed. The term Knowledge Management (KM) has been defined by Carliner (2002, p.6) as captured, stored, transformed and disseminated information aimed at promoting efficiency. According to Carliner (2002), KM promotes "just-in-time learning" and makes use of available databases, intranet sites and other online facilities, such as online chatting and discussion.

According to Cross & Israelit (2000, p.24) learning is the "*process which changes the state of knowledge of an individual or organization*". This implies that they are including only changes in knowledge, unlike others such as Kruse and Keil (2000), who include skills in their definition of learning. Moreover, Rosenberg (2001, p.4) defines learning as a "*process by which people acquire new skills or knowledge for the purpose of enhancing their performance"*. In his definition Rosenberg states that the outcome of learning is to enhance performance and achievements through acquiring new knowledge. From Elkington's (2000) definition that "education is a change of knowledge" and from Rosenberg's (2001) definition of learning, we can come up with the following relationship:

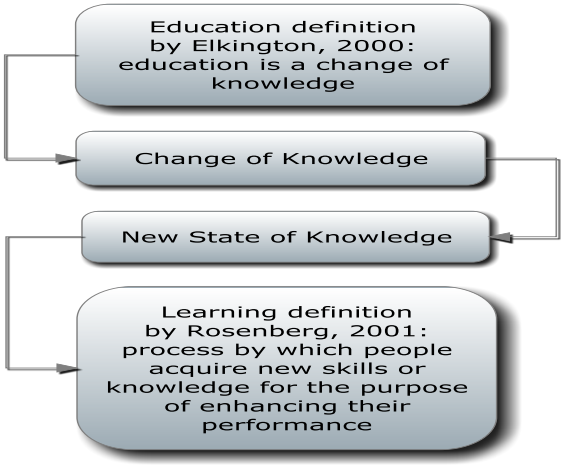


Figure 3. 2: Relationship between Education and Learning

To conclude, the following definitions of knowledge and learning are proposed:

Knowledge is information that has been acquired through a process such as study, research or experience and validated to be used in a given context.

Learning is the process of change in the current level of knowledge/skills, which are considered to be new knowledge/skills and their implementation in a given context for the purpose of enhancing performance and achievements.

Given this definition of learning, there is a need to put it into a theoretical context. The next section will discuss learning theories.

3.2.2. Learning Theories

Learning theories address how individuals learn. The literature in this field is extensive. There are many different theories on how individuals learn have been proposed by scholars such as Piaget (1952) and Skinner (1954). In the same way, implementing e-learning requires a clear understanding of how e-learners learn. According to Gillani (2003), learning theories can be influential in e-learning.

Medsker and Holdsworth (2001) have categorised learning theories into behavioural theory, cognitive theory and humanistic, social and affective learning theories. Such theories support different models of Instructional Design (IS) or Instructional Systems Design (ISD), which mainly focus on exploiting the efficiency and usefulness of instruction, by reflecting on the learning experience through determining the learner's state and needs and by setting up the objectives of instruction. Moreover, according to Bostock (2006), IS is concerned with developing instructions for computers. Bostock explains that the word "instruction" signifies educational presentation, while the word "design" denotes development, implying early analysis, design, delivery, deliberation and evaluation. On the other hand, Bostock argues against naming this process "Instructional Design" and prefers the term "Intervention Development" as this involves any activity performed by the teacher to encourage learning.

ISD is rooted in cognitive and behavioural approaches. This can be seen through the definition given by Medsker and Holdsworth (2001) as "*a set of models and practices that*

are systems oriented, consistent with Instructional Systems Design (ISD), and based on behavioural or cognitive approaches to learning". This implies that instruction facilitates the learning process and is delivered through the instructor (a human or some other form, such as a computer). Gagné & Medsker (1996) confirm this through their definition of instruction as "*the set of events that initiate learning in an individual*".

The researcher will review several learning theories in this section in relation to e-learning environments. Moreover, this will demonstrate the role of learning theories in e-learning development and delivery.

3.2.2.1. E-Learning and Behavioural Theory

The leading advocates of this theory are Ivan Pavlov, with his classical conditioning theory, Thorndike, the creator of connectionism theory, and B. F. Skinner, the founder of operant conditioning theory (Medsker and Holdsworth, 2001). According to Gillani (2003) and Medsker and Holdsworth (2001), behaviourism has dominated the psychology of educational technology and curriculum design. Behaviourism as a theory is based on three basic assumptions. Firstly, learning is noticeable when there is a change in the behaviour of the learner. Secondly, the behaviour is influenced by the environment in which learning takes place. Thirdly, the learning process is explained through the principles of contiguity and reinforcement.

The majority of behaviourists have based their understanding of learning theory on animal research. For example, Pavlov conducted research on dogs, Skinner used rats and pigeons and Thorndike used cats. After conducting such experiments, they applied their findings on animal behaviour to human learning processes (Gillani, 2003).

Behaviourists share a common belief about the basic principles used to design and produce successful learning resources. They believe that education should have a goal, that strong support should be given, that educational materials should follow a logical sequence (starting from the basics and gradually increasing in difficulty until they reach more complex and advanced stages) and that evaluating learners' achievements will all lead to effective learning (Gillani, 2003). Merriam and Cunningham (1989) state that learning activities should follow a given sequence that learners will need to go through. Moreover,

they conclude that the assumption behind the behaviourist's paradigm is to guarantee that learners reach defined learning objectives, which should be easily and clearly observable, and result in a given behavioural outcome.

The two types of conditioning in behaviourism, as mentioned above, are Pavlov's classical conditioning and B. F. Skinner's operant conditioning. Pavlov's classical conditioning focuses on the reflexive response to stimulus. This can be seen in his experiments on dogs. On the other hand, Skinner's operant conditioning (or Radical Behaviourism) focuses on the reinforcement of behaviour either through a reward, which is hoped to increase the probability of the behaviour recurring in either positive or negative responses, or a punishment, which it is hoped will decrease the probability of the behaviour recurring (Gillani, 2003, p.28-30).

Thorndike, the behaviourist who developed connectionism theory, defines learning as "*habit formation, or forming a connection between stimulus and response*". Applying his theory to an educational context, Thorndike developed two laws of learning influenced by reward (Gillani, 2003, p.27):

- *Law of effect:* occurs when establishing a connection between a stimulus and response (S-R), which is followed by a reward that increases the connection.
- *Law of exercise:* deals with the connection between the stimulus and response on one side, and the strength of the connection on the other side. The more the practice is repeated, the stronger the connection will be between the stimulus and the response (S-R) and vice versa.

Behaviourism theories and models emphasise motivation as an aspect of learning. Romando (2007) describes the motivation as "*a driving force that initiates and directs behaviour. In other words, motivation is a kind of internal energy, which drives a person to do something in order to achieve something. It is a temporal or dynamic state within a person which is not concerned with his/her personality".* He also differentiates and categorises different types of motivation, such as achievement motivation, affiliation motivation, competence motivation, power motivation, and attitude motivation.

Thorndike's connectionism theory and those of other behaviourists considered motivation to be a very important aspect of learning. This has contributed to the introduction of extrinsic (external) motivational tools such as reward systems using points and coloured stars. According to Medsker and Holdsworth (2001), the use of extrinsic motivation, such as externally applied rewards, leads to desired behaviours. This is seen clearly in e-learning environments, where practice and drills are used in educational software and tutorials are used as milestones (Gillani, 2003, p.28). Such motivation leads to Skinner's operant response, which he believes to be a human learning behaviour that occurs without operant reason (Gillani, 2003, p.28). However, Schank (1997) argues about the need for motivation to learn.

According to Gillani (2003) and Kruse & Keil (2000), in behaviourism there is an interest in measuring changes in the behaviour of individuals, or in other words, measuring the behavioural and performance objectives. Such objectives are used to support learners in the learning process and provide guidance through courseware development.

Skinner assumes that when a person responds to stimulus in a certain environment, this produces an outcome in the form of a behavioural change. Therefore, when a specific Stimulus-Response (S-R) model is reinforced (rewarded), people are conditioned to respond (Skinner, 1954). Skinner's operant conditioning has influenced many theories and models of learning, such as applied behavioural analysis, the development of schedules of reinforcement, mastery learning, computer-assisted instruction and educational software (Gillani, 2003, p.30).

According to Medsker and Holdsworth (2001), behaviourism has contributed to enriching the theory and practice of instructional design through its ideas and practices. Such contributions have been reflected in teaching models developed based on the principles of behavioural learning theories (Gillani, 2003). This shares some common characteristics, including assessments, intervention and evaluation (Gillani, 2003). These can be seen in educational applied behaviour analysis.

Educational applied behaviour analysis and the Mastery Learning model (formulated by John B. Carroll in 1963) consist of three components. The first is the assessment stage,

aimed at setting objectives and pre-testing the learner's level. The second is the intervention stage, which aims to achieve the objectives through sequenced instructional design plans and practices (Gillani, 2003). Merriam and Cunningham (1989) state that when "*learning activities are sequenced*"; with carefully designed stages which gradually increase in difficulty to reach a complex level, learners will progress from one stage to another (Merriam and Cunningham, 1989). Finally, the third component is the evaluation stage, when the learner's competencies in the objective(s) set for them are evaluated. If the learner's responses meet the objectives then there is reinforcement and they move to the next level. If not, they will be guided back to the intervention stage for further education. Merriam and Cunningham (1989) state that educational activities will be "*evaluated as successful"* if the learning objectives are demonstrated in an acceptable way that meets the proposed and defined learning objectives, which will result in behavioural outcomes in the form of learning.

Applying the ideas and practices of behaviourism such as considering the observable behaviour of individuals. This is considered as a change in individuals behaviour as learning, the use of positive reinforcement (reward) or negative (punishment) as motivational driver to increase chances and occurrence of required behaviour (Skinner's operant conditioning). Dividing the required behaviour into sub-units to be easily grasped and learned, make a special attention to instructional design through setting specific behavioural objectives (applied behaviour analysis). The emphasis and importance of repeating response by the learner (practice) (Thorndike's connectionism theory, low of exercise), making sure that all learners are given the needed time and supported with required provision to learn (proposed by Carroll in his mastery learning model). Applying such ideas and practices in an educational context has a positive impact on instructional design (Medsker and Holdsworth, 2001).

According to Gagné (1965, p.57-58; 1977) there are eight types of learning, distinguished from each other by the conditions that must prevail in order for them to occur. These are signal learning (Pavlov's classical conditioning), stimulus-response learning (Thorndike, Skinner's decremented operant), chaining (Skinner), verbal-associate learning, multiple discrimination learning, concept learning, principle learning and problem solving. Gagné also created nine conditions of learning. These are; gaining the attention of the learners,

informing the learners of the objectives, stimulating the learners to recall prior learning, presenting the content, providing a learning guide, allowing the learners to practice, providing feedback to the learners, assessing the performance of the learners and enhancing retention. (Bostock, 2006). Kruse & Keil (2000) consider Gagné to be one of the main contributors to the systematic behavioural scheme for instructional design and consider his learning model the most convenient method of learning.

One of the most popular instructional design models is the ADDIE model, a systematic model which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. Another is the ARCS instructional design model (based on motivation), which was developed by John Keller (1983) and consists of four main stages: Attention, Relevance, Confidence and Satisfaction.

According to Gillani (2003), the use of behaviourism for the development of e-learning has been carried out since the early 1960s when Patrick Suppes applied behaviourism to technology, resulting in an instructional model called "Practice and Drill". Suppes proposed that his instructional model was ideal for teaching mathematics through splitting the subject into strands, which in turn were structured into skill objectives. These objectives were then presented in the form of exercises. Practice and Drill is an approach where the computer controls and manages the presentation of the learning materials used to develop skills, including structured practice, and tracks the user's actions to provide appropriate feedback. Medsker and Holdsworth (2001) propose that the method will work well in specific subjects, given that learners participate actively, through well-defined constructed sequences, rather than simply viewing the content, and in situations where computer control is desired. Moreover, Gillani (2003) believes that a behavioural approach can serve well in e-learning environments in certain situations. This comes with the agreement with what Dietinger (2003) concludes, as the behavioural approach suits the learning of vocabulary, typewriting, and laboratory work.

3.2.2.2. E-Learning and Cognitive Theories

The word cognitive comes from the Latin verb "cognoscere" which consists of two parts, "co" and "gnoscere" and means "*to be acquainted with, of or pertaining to cognition or to the action or process of knowing*" (Oxford English Dectionary, 2009). Moreover, according to Gillani (2003), cognitive development refers to the mental process that involves acquiring knowledge, storing, and retrieving it to resolve problems.

According to Gillani (2003), the main advocates of cognitive theories and models of instructional design are Piaget (Cognitive Development Theory, 1952), Bruner (Discovery Learning, 1966), Flavell (Cognitive Development, 1985), Papert (1993), Jonassen (1991) and Gagné (Conditions of Learning Theory, 1996).

Piaget (1952) introduced the Cognitive Development Theory and proposed the four concepts, schema, assimilation, accommodation and equilibrium. He conceived the idea that mental adaptation to environmental demands is a cognitive development. Cognitive development was held by Piaget to consist of four stages: sensorimotor (birth to two years old), pre-operational (two to seven years), concrete operation (seven years to adolescence) and formal operation (adolescence to adult). Flavell (1985), however, criticized Piaget for underestimating the learners (children in Piaget's theory); Ausubel (1968) expanded and modified Piaget's work to address these criticisms (Gillani, 2003).

Piaget (1952) conceived learning as a "*dynamic process where learners construct their own knowledge by interacting with the world*" and considered teachers to be the architects of the learning environment (Gillani, 2003, p.60). As a result, a group of educators in the US, who had an immense impact on instructional design, teaching models and educational technology, became known as the cognitivists. Learning is perceived by cognitivists to be an internal process which takes a place in the individual mind and involves "*memory, thinking, reflection, abstraction, motivation, and meta-cognition*" (Ally, 2008, p.8).

Flavell (1976) states that "*meta-cognition refers to one's knowledge concerning one's own cognitive processes or anything related to them, e.g., the learning-relevant properties of information or data. For example, I am engaging in meta-cognition if I notice that I am having more trouble learning A than B; if it strikes me that I should double check C before*

accepting it as fact". The implications of this for e-learning systems can be seen in the form of tools that provide a method of self-planning one's learning, such as calendars and to-do lists that provide several ways of acquiring information, as well as monitoring tools that record the progress of learners and provide statistical reports about their activities within the e-learning system.

There are two different models of instructional design within the constructivism approach: *inquiry* and *discovery* (Medsker and Holdsworth, 2001). *Inquiry* learning utilises what is known about human information processing to ensure that knowledge is stored efficiently in the learners' brains. According to Gillani (2003), the inquiry model has five phases of instruction: puzzlement or intellectual confrontation, hypothesising the intellectual confrontation, gathering and organising data, testing hypotheses and analysing data and evaluating the learner's understanding.

Bloom et al. (1956), one of the main cognitivists, proposed six types of learning, distributed over two levels of skills. They proposed that knowledge, comprehension and application require a lower level of skill and should be acquired first. Only then should the higher level skills of analysis, synthesis, and evaluation be acquired.

As mentioned above, the cognitive approach sees learning as human information processing. Therefore, in cognitive psychology, memory is one of the main issues discussed. According to Ally (2008), memory is an essential part of learning, with the learner making use of different types of memory during the learning process. The three-stage information processing model proposed by Richard Atkinson and Richard Shiffrin in 1968 (the Atkinson-Shiffrin model, also called the Multi Memory Model or Multi Store Model) deals with the memory aspect of cognitive psychology. The model proposes that the memory of a human involves a sequence of three stages, Sensory Register (SR) or Store, Short Term Memory (STM), and Long Term Memory and Storage (LTM). The following figure illustrates the model:

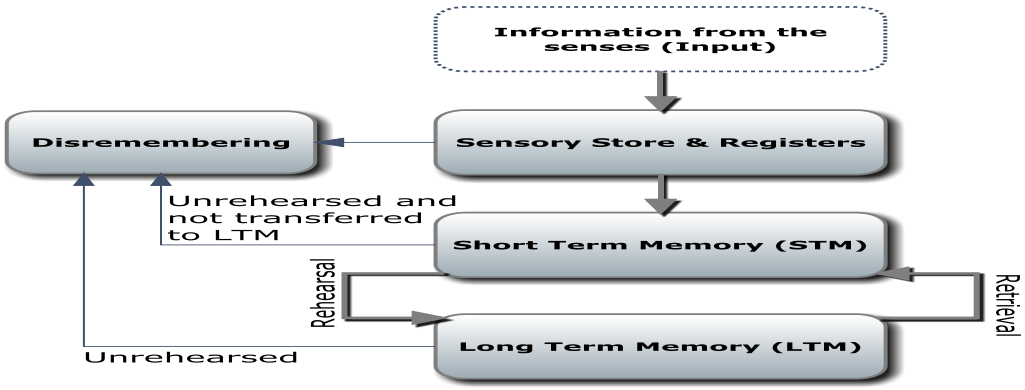


Figure 3. 3: The model of human memory adopted from Atkinson & Shiffrin (1968)

The Atkinson-Shiffrin model explains how the human memory processes presented information. This starts through the learner's senses, that is, the physiological methods of perception, such as vision, audition and the kinaesthetic senses (Ally, 2008). According to Kalat (2007), information perseveres in the sensory store for a very short time (less than one second) and if the information is not transferred to the working memory (STM) it will be lost. Moreover, information stays within the working memory for only a short time (twenty seconds) and if this information is not processed in an efficient way, it will not be transferred to the LTM (Kalat, 2007). Kalat describes this as follows:

- ***Sensory Register (SR)****:* input information enters a SR through one of the sensory perceptions; this lasts for a short time (one to three seconds) and then evaporates through replacement by other information or decay. This is because the SR has only a limited capacity for storing information.

- ***Short Term Memory (STM)****:* in this memory, information can be kept for around five to twenty seconds, if such information is repeated constantly. Because of this limited capacity of the STM, Miller (1956) proposed that information should be grouped and chunked into (7±2) items in a meaningful sequence, as this would increase the STM capacity. According to Coltheart et al. (1983), visual stimuli, such as size, shapes, locations and colours, input through the visual system, are stored in an iconic memory. If this information is processed efficiently in the STM, it will be transferred to the LTM for storage and retrieval in later stages; otherwise, the information will be lost.

- ***Long Term Memory (LTM):*** this type of memory is used when information has been processed efficiently in the STM and is thus stored in the LTM for long term use. Although the LTM has unlimited capacity and is immeasurable in terms of the amount or length of time information can be stored for, information can be forgotten if it is not rehearsed and reinforced by repetition and memorisation. Another aspect of the LTM is known as "flash bulb" memory, where information moves directly from the SR to the LTM, because learners give instant attention to the information.

According to Dietinger (2003) and Medsker and Holdsworth (2001), the problem solving approach is the main way of learning in cognitivism that is "*learner-centred and problem-based*". This can be explained through Ausubel's teaching approach "the Advance Organizer". According to Gillani (2003), "*Ausubel maintained that new ideas could be usefully learned and retained only if students are presented with an "advance organizer" that would map the structure of the discipline*".

According to Ally (2008), using advance organizers will activate any existing cognitive structure. A comparative advance organizer can be used to help learners recall prior knowledge to help their processing, and an expository advance organizer can be used to help incorporate the details of the lesson (Ausubel, 1960). Many studies have been conducted on the effectiveness of the advance organizer and have found that it is very effective when learning content that is presented in unfamiliar forms.

According to Mödritscher (2006), the individual differences between learners (cognitivism being learner-centred, according to Dietinger (2003) and Medsker and Holdsworth (2001) are put in focus in the cognitive paradigm derived from Piaget's theory. Various learning styles, such as that of Kolb (1984) are used to accommodate such differences. Learning styles refer to the interaction between the learner and the learning material. The implantation of cognitive theory into e-learning can be seen in Mayer's (2001) cognitive theory "Multimedia Learning".

In e-learning design, the cognitive paradigm influences the development of educational simulations, intelligent tutoring systems and graphical user interfaces (GUI) (Medsker and Holdsworth, 2001). Moreover, the implication of such thing into e-learning environment

can be seen in the form of tools that can provide self-planning learning tools such as calendar and to do lists that can provide several ways of acquiring information. Moreover, to provide monitoring tools that can monitor the learning progress of the learners and provide statistical report about their activities within the e-learning system.

The implications of discovery learning can be seen in the work of Seymour Papert and Robert Davis (Gillani, 2003). Papert worked and directed the LOGO project, which is a programming language that helps to construct learners' knowledge. Papert perceives the computer as a tool that should be controlled by the user (Gillani, 2003). In contrast, Davis claims that the computer should organize and direct the learner to construct their knowledge. Davis directed the Plato project, which established a multimedia interactive textbox through computers (Gillani, 2003).

3.2.2.3. E-learning and Constructivism Theory

Piaget's work contributed to the introduction of constructivism theory. He suggested that the mental states and capabilities of a learner are responsible for what and when they learn. When new data is to be learned, the mental structure determines whether to integrate the new information if it makes sense or to ignore it.

In constructivism, the learner is the main focus rather than the taught material (the subject). Therefore, according to Ally (2008), advocates of constructivism view the learners as active rather than passive. Constructivists view knowledge as the learner's internal understanding and processing of what their senses are exposed to. Such knowledge is not imposed on them or received from an outside source such as a colleague or instructor.

According to Duffy & Cunningham (1996), the constructivism paradigm perceives learners as constructing knowledge based on their prior experience and knowledge, instead of receiving knowledge through tutors and instructors. Therefore, the role of the tutor or instructor is to facilitate the learning process through activities which could be intellectually or physically-based (Phillips, 2005). Moreover, McLeod (2003) states that knowledge is constructed based on the personal learning experience itself.

The constructivism paradigm perceives the learning process as keeping the learners active and engaged with the learning activities, among themselves and with the help of the instructor. Such activities include group discussions and applying what has been learnt in practical situations (lab-based work) by interacting with other learners (Murphy & Cifuentes, 2001). This force the learners to construct their own personal knowledge by giving it personal meaning (Ally, 2008). This method requires the instructor to provide and introduce the topics to be learned in an interactive way. This means putting learning materials into a contextual form (Hung et al, 2004). In order to contextualise learning, learning materials have to be presented in different ways that give learners genuine knowledge and, at the same time, force them to use and improve their meta-cognitive skills (Mödritscher, 2006). It is clear that an e-learning environment could facilitate these ideas. Moreover, in an e-learning environment, the information provided is contextualised by the learners, while in conventional teaching methods it is the instructors who contextualise the learning material, which may not be appropriate for the learners (Ally, 2008).

In the constructivism paradigm there is an emphasis on collaborative and cooperative learning. It could be achieved in an e-learning environment by using tools such as video-conferencing, chat, online collaborative work spaces, virtual worlds, wikis, blogs and file-sharing (images, video, audio or documents) applications and websites. Such tools would encourage learners to use their meta-cognitive skills, engage in group work, control the learning process and reflect on what they have learnt, which leads to meaningful learning through personal understanding and contextualising. However, according to Ally (2008), the knowledge acquired through such means would still need to be tested and confirmed by the instructor.

Based on the above, interaction happens during learning. Such interaction might be between the learners themselves, with their teacher/instructor, with the delivery medium, instruction interaction or self-interaction. Moore (1996) identifies three types of interaction: learner-content, learner-instructor, and learner-learner. Moreover, Hillman, Willis, and Gunawardena (1994) introduce the idea of learner-interface interaction. Hirumi (2002) proposes three types of interaction in an e-learning environment: self-interaction, human/non-human interaction and instruction interaction.

We now map the different kinds of interaction that can happen during the learning process. First, we discuss the interaction between the learner and the interface, proposed by Hillman, Willis, and Gunawardena (1994). The idea behind this interaction is that learners use their senses to register learning materials into their sensory storage and transfer them to their STM (Ally, 2008). Moreover, it is important that, when such interaction occurs, the learner is able to access, communicate and use the content and validate the knowledge acquired with others. In the e-learning environment, the interface will be the accessing device (computer, personal digital assistant (PDA) or mobile device) and the ability to use such an interface to access the learning content will be vital. It is important to note that learners must have a minimum skill level in using the interface; otherwise, there will be an accessibility issue.

Assuming the learner has accessed the content and learning materials, the learner-content interaction will commence. As the learner navigates through the learning activities, they can experience different sequences of browsing the learning materials and may be able to choose a specific sequence that suits their needs (Ally, 2008). While using the e-learning environment, learners can evaluate, assess, synthesise, apply, analyse and reflect on what they have learnt (Berg, 2002; Ally, 2008). During these actions, information gained through the sense will be transferred from the registers to be processed and used in the STM. The processed information will then be associated and transferred to the LTM (Ally, 2008).

While learners are working through the learning activities, they need to support and interact with each other; this is the so-called human interaction, which can take many forms, including learner-learner, learner-teacher, and teacher-learner interaction (Moore, 1996). Moreover, there will also be another type of non-human interaction. The final interaction is the learner-context interaction. According to Ally (2008), specific strategies should be used to promote this. Applying such strategies will give the learners the opportunity to practice what they have learned in real life. This will lead to them contextualising the content which will ultimately result in them developing and constructing a personal meaning and knowledge (Ally, 2008).

The ELearning Guild (2003) conducted a survey about interaction with instructional content in the e-learning environment and which revealed some of the factors that

determine the types of interaction that occur in e-learning, such as budget, the skills being developed, the instructional needs of the content and bandwidth and technology. This shows the importance of considering the interaction in e-learning as it affects different aspects of e-learning design.

3.3. LEARNING THROUGH THE USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGIES (ICT)

Over the past few years, technology has proved beneficial in facilitating learning and teaching (Arsham, 2002). But before proceeding, there is a need to look at the historical perspective and role of technology in education. The conventional teaching method has existed and dominated for a very long time. However, the use of available tools to facilitate learning has always occurred. Many different tools have been used over time, eventually progressing to the latest technologies, computers and mobile devices. The researcher will limit the scope of the discussion in this section to the adoption of computers to facilitate learning and teaching. This means that the use of other computerised devices, such as mobile devices and PDAs, although of interest, is not included within this study.

According to Hall (2009), in the 1950s, educational television was introduced. However, since the 20s up to the 50s radio and television were used in three general ways: for directly teaching a class as a substitute for the teacher on a temporary basis; general educational programmes for the community; or as school broadcasting to provide correspondence learning which complements the school lessons.

In the 1950s, mainframe computers were used for the first time to model brain functions, teaching binary and keyboarding. Hall states that there were an enormous number of ideas that all contributed towards the development of e-learning technologies in the last century. He reports that the first "*teaching machine*" was developed by Sidney Pressey in the 1920s. An educational psychology professor at Ohio State University, Sidney Pressey's teaching machine offered "*drill and practice exercises, and multiple choice questions*" (Hall, 2009). Skinner later introduced "*programmed instruction*" which is considered a more advanced version of Pressey's teaching machine.

According to Ingale (2010), ICT refers to a technology that is capable of sharing, conveying, storing, creating, and exchanging information by electronic means. This broad definition of ICT allows a variety of technologies to be counted as ICT, such as video cassette recording (VCR), television, radio, mobile, computers and all associated services (Ingale, 2010). Blurton (1999) defines ICT as a "*diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information*".

Ingale (2010) argues that pre-digital technology can be included under the ICT umbrella. However, Ingale divides ICT into three categories. The first includes technologies that store information, such as CDs, DVDs, Blu-ray, or flash memories. The second comprises technologies that process information, such as computers. The final category consists of technologies that transmit and broadcast information, such as telecommunications, television, radio and the Internet. However, these are not broadcasting technologies, but are either receivers, such as television, or media for sending and receiving information, such as the Internet. From another point of view, Ingale's third category can be considered a tool for transmitting information, such as delivering learning materials to learners.

Computers started in the form of electro-mechanical machines or, simply, as calculators. The first electronic computer was built in the mid-1940s. With the invention of transistors, more powerful computers were built and more programming languages and storage media had been introduced to serve different fields (Ingale, 2010).

By the late 1950s, mainframe computers had been introduced to be used for teaching in elementary schools and "computer-aided instruction" was used to deliver drills and practice. According to Horton (2001), from the mid-1960s until the mid-1980s, the PLATO project, which was directed by Davis, evolved to produce over forty million hours of instructional materials.

The year 1960shas witnessed the introduction of the Internet or World Wide Web, by Tim Burners-Lee (Inglis et al., 2002). Burners-Lee's ideas transformed the use of the Internet to exchange electronic mail and files for the retrieval of hyperlinked documents (Inglis et al., 2002). This helped to introduce a new level of communication among the users and helped

educators and instructors to reach a new audience through the new "*Online learning*" and "*Web-based learning or training*". This led Hegarty (2004) to describe the Internet as "*the most pervasive and educationally far-reaching innovation in ICT*".

At the beginning of the 1970s, there was a breakthrough in the use of computers with the introduction of the microprocessor, which enabled personal computing (Ingale, 2010). Other technologies, such as audiocassettes and video recorders, were also introduced for instruction around that time.

The late 1970s witnessed the introduction of the first personal computer (PC), which allowed a wide range of users, including households, to benefit from its capabilities. In the 1990s the possibility of using PCs with multimedia would emerge. This phenomenon caused a boom in computer-based learning, offering users productivity tools and entertainment, such as games (Horton, 2001; Rosenberg, 2001 and Ingale, 2010).

By the end of the 1990s, new technologies included mobile devices (smart phones), PDAs, and wireless technologies which allowed connection to the Internet, such as General Packet Radio Service (GPRS), Enhanced Data Rates for GSM Evolution (EDGE), Wi-Fi and the latest wireless technology, Worldwide Inter-operability for Microwave Access (WIMAX).

Looking at the abovementioned technologies, it is clear that each has contributed to facilitating learning and teaching. Some of these technologies have been replaced with new ones and some are still used today. The following figure shows some of the technology-based learning and its flexibility.

3.4. TERMINOLOGIES OF RECENT TECHNOLOGY-BASED/ENHANCED LEARNING

Technology-based learning (TBL) and technology-enhanced learning (TEL) signify the use of technology as a medium and as a support and enhancement respectively. TEL implies the support of the learning activity, and the facilitation and enhancement of the learning experience through the use of technology. However, it is a broad term describing learning through the use of computers and the Internet, including many other technologies, such as

print technology. Tsai and Machado (2002) mention some recent TBL, such as web-based learning, e-learning and distance learning. However, there are other terminologies such as computer-based learning; Tsai and Machado relate these types of TBL to each other. However, they point out some significant differences between these terminologies. Their main reason is that they believe that failing to differentiate between these terminologies will limit progress and improvement in such fields, which will result in a deprived understanding of the existing alternative solutions.

On the other hand, Koller, Harvey and Magnotta (2006, p4), in their report titled 'Technology-Based Learning Strategies', define TBL as "*the learning of content via all electronic technology, including the Internet, intranets, satellite broadcasts, audio and video tape, video and audio conferencing, Internet conferencing, chat rooms, e-bulletin boards, webcasts, computer-based instruction, and CD-ROM*". Kurse and Keil (2000) use the word training instead of learning, so that TBL becomes technology-based training, partly because they use the term in a business context. Kurse and Keil use the following definition for technology-based training: "*using technology to deliver training and educational materials*". Dean (2002) states that "*technology based training is a bit of catchall term that can be interpreted to include most forms of training that use the computer for delivery. It most often taken to refer to computer based training (CBT) and, web-based training (WBT) and interactive multimedia training*".

Although many people think that learning and training are the same, the researcher will make use of the term technology-based *learning* instead of using the term technology-based *training*. This is due to the fact that the term 'training' is more often used within an organisational context, while the term 'learning' has a broader context.

Learning is self-driven and happens because an individual wants to improve their own life and have achievements – it happens through choice. On the other hand, training happens in the place of work and is imposed on the individuals in order to improve the overall performance of the organization. Rushin Jr (2006) states that "*'Training' suggests putting stuff into people, when actually* ***we should be developing people from the inside out*** *- so they achieve their* ***own individual potential*** *- what they love and enjoy, what they are most capable of, and strong at doing, rather than what we try to make them be*" and "*training is*

(mostly) a chore; people do it because they're paid for it. Learning is quite different. People respond to appropriate learning because they want to; because it benefits and interests them; because it helps them to grow and to develop their natural abilities; to make a difference; to be special" (emphasis added).

Ally (2008) states that various terminologies have been proposed to describe learning through technology (mostly this is a computer), such as online learning, computer-based learning/training, multimedia learning/training, Web-based learning/training, e-learning, net-based learning and intranet/Internet-based learning/training.

Based on the understanding of the terminologies, how these terminologies may fit together will be explained, starting with the term computer-based learning. The term computer-based computer means using a computer that is connected to other computers to facilitate and enhance learning. The computer will be used either online or offline, resulting in online or offline learning. See the figure below for details:

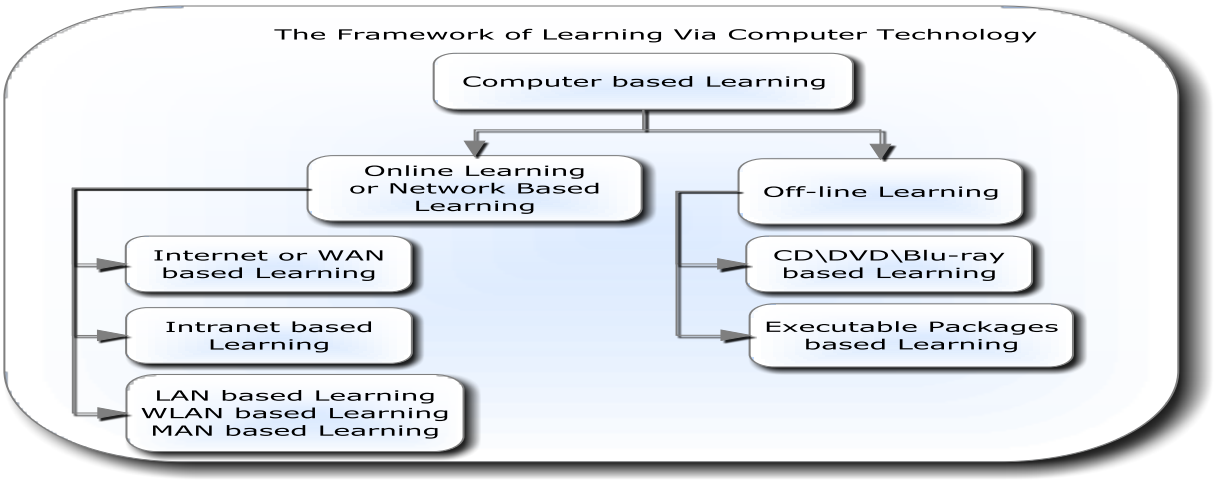


Figure 3. 4: Framework of Learning via Computer Technology

According to Overfield and Bryan-lluka (2003), the learning experience is enhanced through the increased use of computer-based learning (CBL). In CBL, tutors do not have to supervise learners' progress while they are using the learning applications (Greenhalgh, 2001). Moreover, Harriman (2004) mentions other acronyms used for CBL, such as computer-based instruction (CBI), computer-assisted instruction (CAI) and computer-based training (CBT). Harriman defines CBI as "*the use of the computer as a self-contained*

teaching machine to present individual lessons". On the other hand, CBT is described by Zahm (2000) as multimedia-based training usually brought to learners through a Web download or a CD-ROM. At that time, the computer was used for CBI, CBT, or CBL, which are all considered types of offline learning. However, there was a need to track the learner's progress and organise their learning process. This resulted in the introduction of computer-managed instruction (CMI) (Harriman, 2004).

Part of Zahm's (2000) description of CBT is the use of "CD-ROM" this means that offline learning is within his consideration. CD-ROM or Compact Disc Read Only Memory is well-known as a storage medium for a long time. It is used to dispense multimedia applications and all kinds of software, including educational, games and operating systems.

In the mid-1990s, several companies, such as Sony, Toshiba and Phillips, developed the Digital Video Disc or Digital Versatile Disc (DVD). In comparison to the CD, the DVD has the upper hand in terms of capacity, which allows larger amounts of video and data to be stored, although they are the same in terms of physical size. There are variations such as DVD+RW and DVD-WR which allow for the recording and re-recording of data several times, unlike the CD-ROM. The introduction of such technologies offered educators more ways to expand their educational delivery tools. Rosenberg (2001) mentions CD-ROM-based training as a delivery tool for instructional materials and courses. However, the CD-ROM and DVD lack networking ability and real-time interactivity with instructors, because of the static nature of the learning materials and courses delivered through such media.

On the other hand, Ally (2008) proposes the following definition for online learning: "*the use of the Internet to access learning materials; to interact with the content, instructor, and other learners; and to obtain support during the learning process, in order to acquire knowledge, to construct personal meaning, and to grow from the learning experience*."

Online learning is defined in a report by Blackboard (2000) as "*an approach to teaching and learning that utilizes Internet technologies to communicate and collaborate in an educational context. This includes technology that supplements traditional classroom training with web-based components and learning environments where the educational process is experienced online*". In the same report, its benefits are deliberated, including

enhancing user communication (learner control), continuous accessibility to learning resources (accessible from anywhere), reducing the administrative workload and time, and providing users with different types of learning approaches (personalised learning).

In his definition of online learning, Naidu (2006) includes"*all learning activities that are carried out over an electronic networked environment, such as an intranet or the Internet*". Based on the above definitions, we can see that there is an agreement on the use of the term *Internet* and, in Naidu's case, this is expanded to include the term *intranet*. Moreover, Mason (1998) categorises online learning into "*full online learning*" and "*partially online learning*".

Based on this, it can be concluded that both Internet-based learning and intranet-based learning exist. Educational materials are increasingly being delivered through the Internet. Moreover, the use of Internet-based learning allows learners to study at their own pace, gives them more accessibility to educational materials from anywhere and at any time without traveling or wasting time (Quintana, 1996). According to Tait (1997), Internet-based learning can be considered as global software with global access bringing important advantages such as providing direct links between tutor and students and providing massive amounts of educational content.

Quintana (1996) states that a wide variety of technologies are used to deliver learning materials on the Internet, such as forums, e-mails, virtual reality and that the increased use of multimedia enhances the learning experience. However, Quintana questions the effectiveness of Internet-based learning methods. He looks at both the benefits and limitations of using Internet-based learning. Among the benefits he includes the flexibility of studying at one's own pace, being able to interact with colleagues separated by distance using real-time technologies such as video-conferencing, chatting by text or by voice (synchronous communications), the elimination of the need to travel or at least reducing this to a minimum, and the use of asynchronous technologies, such as forums, newsgroups or discussions. Limitations include that the learner may drop out because of a lack of motivation, it may be costly for some individuals and institutions, which may limit its use, there may be inappropriate technical support, and the learner may not be able to express himself/herself, compared to in conventional methods.

However, Nakatani et al. (2001) proposed a method for creating effective Internet-based learning environments by using a conversational tone in the instruction, as this will help learners to sense and interact with the teaching style and personality of the teacher. This should be combined with just-in-time instructions in the course delivery.

With the introduction of Internet-based learning, web publishing tools and HTML editors are now used by learners and educators post videos, animations and assignments. Moreover, intranet-based learning has contributed towards virtual online organisations, such as the Open University and South Korean universities such as Korea Cyber University and the Open Cyber University. Such institutions provide Internet-based courses using technologies that utilise rich media and just-in-time support systems. Internet-based learning has forced companies to shift their development from general computer-based learning and tutorials using CD-ROMs to hybrid models accessed within Internet browsers. Moreover, intranet-based learning has forced them to develop more interactive and sophisticated learning environments that incorporate collaboration tools such as video conferencing, synchronous and asynchronous tools, forums and online discussion boards.

Intranet-based learning is similar to Internet-based learning except that it exists within organisations (particularly business organisations). Moreover, intranet technologies enhanced the quality of education and training by providing an integrated learning resource (Sosabowski, Herson & Lloyd, 1998). An intranet is a network that is accessed only by authorised users, usually protected by a firewall. In the case where an intranet is connected to the Internet to allow authorised users access to its resources, it is termed an extranet (HCI Data, 2007).

According to Hall (1997), either an Intranet or the Internet can be used to deliver web-based training. However, Rosenberg (2001) states that the term CBT has evolved into Internet-based or web-based training. Moreover, McKimm, Jollie & Cantillon (2003) use the term "web" as a synonym for the Internet and conclude that the web is used to deliver online learning and as a learning tool. However, they point out that technology itself might be one of the main barriers to learning (as a result of low bandwidth or inappropriate hardware).

McKimm, Jollie & Cantillon (2003) state that web-based learning has contributed to a change in distance-learning strategies and the use of communication technologies to support learning as the web is capable of offering live/recorded video-streaming, discussion forums, e-mails and online learning materials. They define web-based learning as "*online learning or e-learning*".

As mentioned earlier, Mason (1998) categorised online learning into fully and partially online courses. In fully online learning courses most of the activities are conducted online (all learners at some point will use printed resources, such as textbooks and papers).
On the other hand, a partially-online course will integrate some elements of online learning with other non-printed or printed resources. This is commonly known as "*blended learning*". Jacobs (2003), Rooney (2003) and Dziuban, Hartman & Moskal (2004) describe blended learning as a combination of face-to-face and online methods. Vaughan (2008) describes it as "*the thoughtful fusion of face-to-face and online learning experiences*" while Chen (2009) refers to it as "*an educational methods that combines the advantages of new paradigm of a remote educational system*".

Certainly, blended learning is not a new concept in the field of learning, having existed for a long time. One example of blended learning is the old classrooms with some oral discussion and some writing on a blackboard, with printed notes to be studied at home at the learner's own pace. Blended learning, according to Goel (2010), offers "*the required extension of learning in space and time*".

Bonk & Graham (2006) noted that different models of blending occur at different organisational levels. They state that blended learning happens at the activity level, the course level, the program level and the institutional level. Moreover, Singh & Reed (2001) describe various dimensions of blending, such as the blending of offline and online learning, or of self-paced and live learning, collaborative learning and the blending of work and learning.

3.5. E-LEARNING

McKimm, Jollie, & Cantillon (2003) define web-based learning by using the term "*e-learning*" where the "*e*" stands for "*electronic*" and "*learning*" signifies the process of acquiring new knowledge in terms of enhancing achievement as discussed earlier in this chapter. However, the word "e" within the term " e-learning" means doing this in a digital way. Thus, it is digitalised learning.

E-learning has been viewed by researchers and educators as a natural progression from CBT, in which the delivery was either synchronous or asynchronous through CD-ROMs, DVDs, or area networks (Local Area Networks or the Internet). However, e-learning means different things to different people. According to Broadbent (2002), *"it seems that everyone, from e-Learning theorists and practitioners, to vendors and learners, are applying the term e-Learning to very different methods and products".* Many different definitions have been proposed for e-learning by researchers and educators. In the context of this research, a review of several e-learning definitions is given in the following section.

3.5.1. E-Learning Definition

In their definition of e-learning, Shoniregun and Gray (2003) separate the term e-learning into two phases, the first of which describes the delivery system as an electronic medium of delivering learning materials and the second of which handles the sustainability of the quality standards of the learning materials, deprived of any consideration of location.

Fallon & Brown (2003) define e-learning as "*any learning, training, or education that is facilitated by the use of well-known and proven computer technologies, specifically networks based on internet technology*". In Fallon & Brown's definition, the need for network-based technology such as intranet or the Internet is clearly emphasised. Morrison (2003) defines e-learning as "*the continuous assimilation of knowledge and skills by adults stimulated by synchronous and asynchronous learning events-and sometimes knowledge management outputs-which are authored, delivered, engaged with, supported, and administrated using internet technologies*". This definition focuses on Internet technologies, knowledge management outputs and learning events that are stimulated by the use of synchronous and asynchronous methods.

New Zealand's Ministry of Education (2004) defined e-learning as "*learning that is enabled or supported by the use of digital tools and content. It typically involves some form of interactivity, which may include online interaction between the e-learners and their teacher or peers. E-learning opportunities are usually accessed via the internet, though other technologies such as CD-ROM are also used*". In this definition, we can see that learning has been digitalised, introduces user interactivity and is delivered through the use of a networked medium and CD-ROMs. On the other hand, Rosenberg (2001) excludes CD-ROMs (and DVDs) from his definition of e-learning.

Moreover, Comerchero (2006) describes e-learning as "*a means of education that incorporates self-motivation, communication, efficiency, and technology*". In this definition of e-learning, new terms have been added such as efficiency and self-motivation. Comerchero uses the term self-motivation to overcome the limited social interactions which require e-learners to be well motivated. Moreover, Comerchero includes efficiency to emphasise the elimination of distance and travelling.

The European Commission defines e-learning as "*the use of new multimedia technologies and the internet to improve the quality of learning by facilitating access to resources and services as well as remote exchange and collaboration*". In this definition, the aim of improving the quality of learning is added. It is hoped that this will be achieved through collaboration and ease of access to resources through the use of the Internet and multimedia technologies. Diaz (2004) emphasises the use of the terms quality, access, exchange and collaboration in this e-learning definition. It is clear that Diaz includes online and offline-based learning technologies, which are used by single learners or a group of learners to facilitates and improve educational activities.

In the context of this research, e-learning will be defined as the use of networked computers and ICT to deliver learning materials and content in the form of web-based courseware, using a LMS/LCMS '*Moodle*' as a portal, to deliver mathematics topics to third grade deaf pupils in Jordan, with the aim of enhancing the academic achievements of the learners by exploiting the facilities and services provided by e-learning and ICT.

3.5.2. E-Learning Classification

There are different categories and types of e-learning which, according to Comerchero (2006), are based on the technologies used the means of communications, the e-learning class structure and the schedule. The researcher will also address classifications based on whether the learning is asynchronous, synchronous, and face-to-face, self-learning, blended synchronous and blended asynchronous.

3.5.2.1. Technology

Categorising e-learning based on the technology used depends mainly on the advancement and enhancements of the technology itself. As an example, the Internet, at first communication was achieved through dial-up modems with slow connection speeds and low bandwidth, later replaced by Ethernet modems which offer high speed connection and high bandwidth. This change has affected intranet-based learning by improving the quality of the delivered educational content in terms of downloading and uploading speeds and content size. Another example involves mobile handsets, which nowadays are connected to the Internet at all times and provide services such as e-mail, chat and web-browsing; their capacity and storage have also been expanded. Therefore, it can be seen that technology is a very important element of e-learning and can be one of the main barriers to its deployment (Rosenberg, 2001; Comerchero, 2006).

3.5.2.2. Means of Communication

When categorising e-learning by means of communication used in the learning activities, this usually refers to whether the communication occurs among the learners themselves or with their instructor. It also refers to whether the communication happens face-to-face (which means there is physical presence) or through the use of communication facilities provided by the e-learning system, such as chat, e-mail, audio/video-conferencing and forums. This is considered to be blended e-learning.

Comerchero (2006) states that blended e-learning contain elements of “in-person interaction” and “web interaction”. The use of synchronous or asynchronous communications will determine the communication tools that are used within the e-learning environment. As an example, the use of face-to-face communication, using technology

such as audio/video-conferencing requires a two-way communication, which creates blended e-learning.

According to Fallon & Brown (2003), there is also a classification of e-learning types based on differences in traditional learning strategies. Fallon & Brown classify e-learning into two broad categories, asynchronous and synchronous. On the other hand, Negash & Wilcox (2008) use six categories. There is on-going debate about the effectiveness and usefulness of each classification of e-learning. Therefore, there is a need to address each of these classifications. In this context, some of the following classifications will be used within this research.

Asynchronous

Fallon & Brown (2003) define asynchronous e-learning as "*a Web-based Version of Computer Based Training (CBT), which is typically offered on a CD-ROM or across organisation Local Area Network (LAN)*". Negash & Wilcox (2008) state that asynchronous e-learning or e-learning without the presence and with e-communication, is what most people think of when they consider "*online learning*". In this mode of delivery, the teacher and e-learner do not get together physically or virtually in a "live" session. However, there is rich e-communication and interaction between them through means such as e-mail, discussion boards, assignments and lecture notes that can be accessed online. Moreover, in this mode the content delivery and access happen separately.

Research shows that *asynchronous e-learning* is more common and tends to be preferred because of the asynchronous nature of the e-learner and its flexibility in providing on-demand learning, allowing the learner to take courses at their own pace (Hrastinski, 2008; Fallon & Brown, 2003). In this context, the researcher used this classification to deliver learning content through the LMS. This classification suites the schools and class environment in Jordan, therefore it has been agreed with teachers to use this classification during schools time (8:00 am – 2:59 pm).

Synchronous

Fallon & Brown (2003) define synchronous e-learning as: "*a learning model to emulate a class room course, lecture or meeting using internet technologies*". Negash & Wilcox (2008) describe it as a "*real-time*" learning delivery mode and a form of e-learning with a *virtual presence* and *e-communication*.

In this mode of delivery, the content is delivered over the Internet and is accessed simultaneously and in real-time; the teacher and the e-learner get together virtually with rich "*live*" interaction occurring between them (*two-way*) in a "*live*" session. In such interactions, both asynchronous and synchronous live e-communication is used, such as instant messages, real-time chat and video and/or audio-conferencing (live streaming). Usually, this type of delivery mode is used to overcome geographical obstacles (when it is hard to travel and attend a course in person) (Fallon & Brown, 2003).

When there are no face-to-face meetings, this mode is considered as a purely online mode of delivery. Synchronous e-learning require all participants and e-learners, as well as teachers, to be online at the same time. It offers live collaboration among the participants and thus facilitates collaboration (Fallon & Brown, 2003).

Face-to-Face

Face-to-Face or *E-learning with Physical Presence and without e-communication*, is the third of Negash & Wilcox's (2008) classifications. They consider this delivery mode to be "traditional" face-to-face classroom e-learning. Hence, they therefore consider face-to-face as a part of e-learning, basing their argument on the daily use nowadays of face-to-face classrooms and the increased use of e-learning and ICT tools to support instruction. Their claim is based on the use of projectors to present PowerPoint slides, white-boards, and TV flat screens.

In this mode of delivery, the teacher and e-learners are physically attending the class, communication takes place in a physical sense (in the class or in the teacher's office) and the content delivery occurs in the classroom. However, some interaction through e-learning tools takes place through e-mail, discussion boards, assignments and lecture notes given outside the classroom and not during class.

Self-learning

Self-learning or *e-learning without the presence and without communications* is the fourth of Negash & Wilcox's (2008) classifications. In this mode of delivery, the content is accessed by the learner independently through e-learning. It is sometimes also called self-based e-learning. In this mode of delivery, the e-learners learn and access learning content and materials at their own pace. The content can be pre-delivered in electronic form through recorded media such as CD-ROMs or DVDs. This is called offline, self-paced e-learning. Alternatively, in online self-paced e-learning, e-learners access the learning materials using the Internet or intranet. In this form of delivery, neither interaction nor e-communication takes place between the teacher and the e-learner and there is no physical presence of any type (Negash & Wilcox, 2008).

Blended/Hybrid Asynchronous

Blended/hybrid asynchronous or *e-learning with occasional presence and with communication* is the fifth of Negash & Wilcox's (2008) classifications. This mode of delivery is a mixture of face-to-face and asynchronous e-learning. Therefore, the elements of this delivery mode are in the form of occasional physical presence and meetings with extensive use of e-communication (virtual) among the users. The blending element comes from the face-to-face and rich e-communication and interaction and the asynchronous part in the form of e-mail, discussion boards, assignments and lecture notes that can be accessed online. It is important to note that content delivery and content access might have attributes of e-learning with physical presence and without e-communication and e-learning without the presence and with e-communication (Negash & Wilcox, 2008).

Blended/Hybrid Synchronous

The blended/hybrid synchronous or *e-learning with presence and with communication* is the sixth classification. This mode of delivery is a mixture of face-to-face and synchronous e-learning. Therefore, the elements of this delivery mode include physical and virtual presences. Virtual meetings occur, with extensive use of e-communication among the users and physical meetings occur with extensive use of the e-learning face-to-face delivery mode where users utilise the classroom for part of the time and "live and virtual" meetings the rest of the time (Negash & Wilcox, 2008).

The blending element comes from the occurrence of the physical presence during the face-to-face meetings and the rich e-communication and interaction in the synchronous part in the form of live video-conferencing (streaming), instant messages and sound (voice streaming). It is important to note that content delivery and content access might have attributes of e-learning with physical presence and without e-communication and e-learning with presence and with e-communication. In this context, the researcher used this classification to deliver learning content through the LMS. Therefore, it has been agreed with teachers to use this classification during schools time (3:00 pm – 7:59 am).

3.5.2.3. E-Learning Class Structure

Here, e-learning is categorised in terms of how it is administrated, that is, whether it is self-paced or instructor-led (Comerchero, 2006). Self-paced learning can be structured within a given time frame and can be supported by an individual instructor. It allows the learner to administrate their own learning process and supports them with all the needed learning materials to stay on schedule and meet deadlines. In this mode, the learners are not constrained by time or place. Morrison (2003) considered self-paced learning, as a type of asynchronous learning, claiming that there is a delay between the authoring time and the learning time (the access time).

On the other hand, instructor-led training/learning gives the instructors and trainers the opportunity to lead and guide the learning process. Therefore, they are the ones who administrate the learning process (Comerchero, 2006). However, the mentoring level may vary from a total guidance role to an advisory role. The third type of class structure is self-study with an expert. According to Comerchero (2006), in this type, interaction takes place between learner and teacher, to monitor progress.

3.5.2.4. Schedule

Here, e-learning is categorised based on timing and technical issues. As an example, when using synchronous learning, there is an assumption of using online chatting and video/audio-conferencing. However, using such facilities requires the instructor or colleagues to be online at the same time. This involves real-time communication and interaction among the users within a given time-frame and schedule. Meanwhile, when

using asynchronous learning, users are required to use e-mails, forums, blogs and threaded discussions and such implementation does not require scheduling.

3.5.3. E-Learning Components

Fallon & Brown (2003) state that e-learning components consist of the physical and the conceptual and emphasise the importance of distinguishing between these two categories, the conceptual components consist of lessons and courses. The physical (or at least electronic) component includes the database, the learning content files and the management software.

Fallon & Brown's (2003) proposed concept of physical e-learning components is vague. Therefore, e-learning components can be divided into three categories. The first is the software components, such as courseware, the LMS, and the LCMS. The second component of e-learning proposed here is the hardware components, such as computers or PCs, laptops, PDAs, networks such as the Internet and intranet and media storage devices such as CD-ROMs and DVDs. The third component proposed in this study in this context is the conceptual component as proposed by Fallon & Brown (2003). Table 3.1 shows the e-learning components as proposed by Fallon & Brown (2003):

Table 3. 1: e-learning components by Fallon & Brown (2003)

Conceptual components	Physical components
• Learning Objects and the reusability issue • Content structure • Curricular taxonomies • Standards & specifications compliance models • The Aviation Industry CBT (Computer-Based Training) Committee (AICC) • Sharable Content Object Reference Model (SCORM) • IMS (Instructional Management System) Global Learning Consortium	• Courseware • LMS • LCMS • Collaboration tools • Assessment systems • Development tools.

The reason behind categorising these into three instead of two components is because Fallon & Brown (2003) considered courseware, LMS, LCMS, collaboration tools, assessment systems and tools, development tools and administrative tools as physical

components while all of these are software or at least are in electronic form. However, it is important to note that there are hardware components which are required to allow access to the software components and conceptual components. The following table illustrates the proposed e-learning components:

Table 3. 2: Proposed e-learning components

Conceptual Components	Hardware Components	Software Components

• Learning objects and reusability issue
• Content structure and curricular taxonomies
• Standards & specifications compliance models
  ○ The Aviation Industry CBT (Computer-Based Training) Committee (AICC)
  ○ Sharable Content Object Reference Model (SCORM)
  ○ IMS (Instructional Management System) Global Learning Consortium
	• PDAs, Mobiles (Smart phones), Computers and Laptops
	• Area Networks (Internet, intranet, LAN, WLAN, WAN)
	• CD-ROMs and DVDs
		• Courseware
		• E-learning Systems
		  ○ LMS
		  ○ LCMS
		  ○ Collaboration tools
		  ○ Assessment systems and tools
		  ○ Development tools
		  ○ Customisation
		  ○ Administrative tools

3.5.3.1. Conceptual Components

Learning Objects and reusability issue

According to the Institute of Electrical and Electronics Engineers (IEEE) Learning Technology Standards Committee (LTSC) (2002), Learning Objects (LO) include "*any entity, digital or non-digital, that may be used for learning, education or training*". In this context, the use of digital forms of LO in the e-learning environment is vital, as is converting non-digital into digital LO. Morrison (2003) provides more details, describing LO as "*a self-contained reusable unit of e-learning content*". An enterprise can derive value from learning objects when they are organised in a metadata classification system and stored in CMS or LCMS. Wiley (2003, cited in Beck, 2009) explains the purpose of using LO in an e-learning environment: "*The main idea of 'learning objects' is to break educational content down into small chunks that can be reused in various learning*

environments, in the spirit of object-oriented programming". Fallon & Brown (2003) express a similar view on the purpose of using LO.

LO components contain some information types that help to distinguish them from other LO, such as general course descriptive data, life cycle, instructional content, glossary of terms, quizzes and assessments, copyrights and educational level (IEEE, 2002). This helps LO to be self-contained and independent of the context, resulting in it being reusable for other courses. Almasri (2009) used the LO in Location Based Systems (LBS) to deliver learning materials to mobile learners through mobile devices (smart phones) and PDAs over mobile networks. Although the LO size is very important, Fallon & Brown (2003) and Beck (2009) disagree over the impact of the size of the LO in terms of usability and reusability.

Regarding reusability, the Instructional Transaction Theory proposed by Merrill (1999) has been criticised by Wiley (2000) as this theory requires a huge number of Tera-bytes in the exiting media to be re-prepared and formatted into current standards.

Content structure and curricular taxonomies

The content structure is a set of LOs that comply with major e-learning standards. Regardless of how the learning content is delivered, any course can be divided into lessons and then divided further into topics (Fallon & Brown, 2003). In this context, the content takes on a hierarchical structure.

Fallon & Brown (2003) define curricular taxonomies as a "*set of named hierarchical learning levels*". They may contain a specific and fixed number of levels, such as (Lesson > topic > Unit or Chapter > lesson). Curricular taxonomies are usually determined by the teacher or the software capabilities and its complexity.

E-learning Standards & Specifications Compliance Models

From a historical perspective, standards have proved to be fundamental in maintaining and revolutionising any system. As an example, in the Internet field, common standards, such as HTTP, HTML, and TCP/IP have been very important in allowing different platforms, such as Windows, Macintosh and Linux, to exchange files and data. Similarly, in the

television industry, PAL, NTSC and SECAM are common standards. Clothes and shoes sizes are another example. When we buy shoes in a size 42 or 8, for example, we do not need to know what those sizes mean, just that they fit us. Similarly, internet users do not think about whether they are using HTTP or HTML; they simply use the Internet.

In the same way, standards in the e-learning field have contributed towards revolutionising the field. Standardising e-learning came to reality through the efforts of different consortiums, organisations and research communities. Table 3.3 shows some of these bodies.

Table 3. 3: e-learning Standards Bodies

e-learning Standard Bodies	Website
AICC – Aviation Industry CBT Committee	http://www.aicc.org/dev/
IMS (Instructional Management Systems) Global Learning Consortium Inc.	http://www.imsglobal.org/
The ADL (Advanced Distributed Learning) Initiative	http://www.adlnet.gov/Pages/Default.aspx
Microsoft LRN	http://microsoft-lrn-toolkit.software.informer.com/
IEEE LTSC - Learning Technology Standards Committee	http://www.ieeeltsc.org:8080/Plone
Ariadne – Alliance of Remote Instructional Authoring and Distribution Networks for Europe	http://www.ariadne-eu.org
Schools Interoperability Framework (SIF)	http://www.sifinfo.org/us/index.asp
Dublin Core Metadata Initiative	http://dublincore.org/

The main reason for having e-learning standards is to achieve interoperability (Stracke, 2010). Interoperability is defined in the IEEE Glossary (2010) as "*the ability of two or more systems or components to exchange information and to use the information that has been exchanged*". Morrison (2003) describes interoperability in the e-learning context as "*the ability of learning content to run on different Learning Management Systems without modification*".

According to Morrison (2003), e-learning standards have been developed to deliver interoperability, reusability, manageability, accessibility, durability and affordability. The increased rate of LO development has resulted in a widespread collection of curricular taxonomies. Therefore, Morrison describes interoperability in e-learning systems as the ability to run different content developed using different authoring tools on the same LMS,

and to use all the intended functions and features of the learning content. LMS will be discussed in the next section.

Morrison (2003) also states that e-learning standards cover areas such as content metadata, content packaging, content sequencing, question and testing interoperability, learner profiles and run time environments. According to UȚĂ (2007), IMS, AICC, ADL and IEEE are four of the main organisations and bodies that have contributed to the development of e-learning standards.

Some of the best known and most widely accepted e-learning standards are AICC (Airline Industry CBT Committee), IMS (Instructional Management Systems), and SCORM (Sharable Content Object Reference Model). It is outside the focus of this research to engage in an in-depth technical discussion of these e-learning standards, but it can be argued that it is critical to explore whether learning technologies are compliant with these standards before an organisation selects, implements and integrates technology systems to support e-learning.

The AICC develops the guidelines and recommendations (AGR) for developing, delivering, and evaluating e-learning technologies (Lesage, Riopel, Raiche, and Sodoke, 2008). According to UȚĂ (2007), the AICC developed Courseware Delivery Stations (or AGR 002), Web-Based Computer Managed Instruction and Computer-Managed Instruction guidelines for interoperability (AGR 006 and AGR 010) and Courseware Interchange guidelines (AGR 007). Moreover, UȚĂ (2007) states that Advanced Distributed Learning produced the Sharable Content Object Reference Model (SCORM), which is a collection of e-learning standards that defines web-based learning in terms of a "Content Aggregation Model (CAM)", which assembles, labels and finally packages the learning content (UȚĂ, 2007). Another part of SCORM is the "Run-Time Environment (RTE)" which is responsible for starting and initiating the learning content in the LMS and maintaining and tracking, transferring data and handling any errors that may arise (UȚĂ, 2007). The final part of SCORM is "Sequencing and Navigation (SN)", which is responsible for the navigation in the learning content and determines how the learning content is sequenced and approached by the learners (UȚĂ, 2007).

3.5.3.2. The Hardware Component

In this part, the hardware infrastructure available for e-learning is addressed. E-learning can be delivered through the use of different hardware infrastructures. The hardware components are very important as this is how the learner will access the other components of e-learning.

In this context, the hardware component is a tool through which the learner requests and receives the needed information in the form of e-learning materials such as text, short videos, pictures or any other multimedia format. E-learning materials can be delivered through computing devices such as PCs, notebooks, mobile devices (smart phones), PDAs or other information and communication tools. E-learning materials cannot be delivered through such devices without a carrier medium, such as area networks such as LAN, WLAN, WAN, or an intranet. Alternatively, CD-ROMs and DVDs could be used.

Previously, PCs and laptops were considered the usual medium for delivering e-learning. However, with the rapid development and advancement in mobile networks, mobile devices (smart phones) and PDAs have become an additional medium for delivering e-learning and a new term has evolved from using such technology in learning, mobile-learning (or m-learning). Almasri (2009) used PDAs in LBS to deliver learning materials to mobile learners to obtain orientation information about an unfamiliar real world environment.

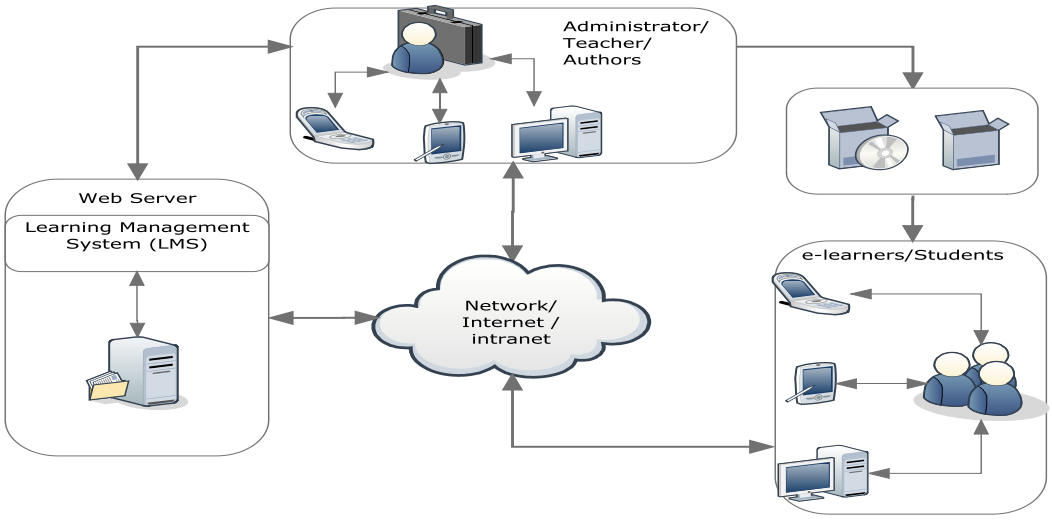


Figure 3. 5: Hardware Components linked to the LMS

3.5.3.3. The Software Component

Courseware and e-learning systems and platforms are the main components of e-learning. E-learning systems will be discussed in the next section. Courseware is the combination of the words 'software' and 'course'. According to Velsoft (2010), courseware is course materials that have been produced in a software format. Courseware is thus software that has been designed and structured to offer flexible, instantly accessible and customisable educational materials. Courseware formats can vary from PowerPoint slides, to PDF files, flash files, and Microsoft word documents, to complex interactive pages that contain animations, with the use of movies and sounds, or HTML (HyperText Markup Language).

Courseware is written using authoring tools, developed and supported by companies such as Macromedia, which merged with Adobe to produce e-learning authoring suites of tools. Online authoring tools also exist, through which users can develop courseware online, for example, through the use of websites such as MY UDUTU. Here, authors publish their developed courseware either on the same website or by importing the courseware to their own LMS.

The third type of authoring tool is Open Source, which are produced to be used free of charge. In this context, open source means that you can use the software without a license that might otherwise hinder the user from adding to, changing and accessing the source code. Table 3.4 shows some of the available commercial and open source authoring tools.

Table 3. 4: Commercial and Open Source Authoring Tools

Authoring tool	Company or Body	Website	License
Macromedia Authorware	Macromedia	No longer supported after the merger between Macromedia and Adobe	Commercial
Adobe e-learning suite	Adobe	www.Adobe.com	Commercial
eXe authoring tool	University of Auckland, The Auckland University of Technology, and Tairawhiti Polytechnic.	www.exelearning.org	Free of charge, open source under GNU General Public License

Xerte and Xerteonline toolkit	University of Nottingham, the UK.	http://www.nottingham.ac.uk/xerte/	Free of charge, open source under GNU General Public License
Wondershare Rapid E-Learning Suite	Wondershare	http://www.sameshow.com/e-learning-suite.html	Commercial
Articulate e-learning software tools	Articulate	http://www.articulate.com/	Commercial
UDUTU online course authoring	UDUTU	http://www.udutu.com/index.html	Free authoring, free extraction and importing to own LMS server, charges apply in the case where the course is hosted by the company's servers

According to Fallon & Brown (2003), there are two main sources of courseware; the first source is custom content. Custom content is used for special and unique training provided to individual organisations and institutions, such as orientation for new staff. Such courseware could be developed either by the institution itself or by a third party.

On the other hand, off-the-shelf or generic learning content is developed by parties who anticipate the learning needs of the market in general. For e.g Velsoft (https://velsoftcourseware.com/) is a company that produces computer skills courseware, such as Microsoft Word and PowerPoint courseware.

3.5.4. E-Learning Systems

3.5.4.1. Learning Management Systems (LMS)

The Learning Management System (LMS) is generic software that manages and tracks the learning processes of learners and teachers. According to Clarke (2006), LMS is a web-based database that uses the web as a portal to track and manage the learning activities of the learners. According to Landon, Henderson & Poulin (2006), it is a platform that provides and enables the management, delivery and tracking of online and blended learning. Fallon & Brown (2003), describe it as "*a web server-based software application that provides administrative and data tracking functions*".

Fallon & Brown (2003) state that LMS is used to manage and sequence the access to the learning materials, and the level and usage of the content. Moreover, LMS record all user activities and preferences and generate statistical information about the level of use, including number of users, the time spent on a specific course by a specific user, assessment tracking, user activities and what tools are used by them, and when a course is started and finished, which give a clear idea about what the users like and dislike or find interesting. Having such information will help to increase or decrease the use of certain assessments, courses, and tools. For example, having a high percentage of uncompleted courseware may indicate that it is poorly-structured and requiring revision. The information gathered will give a clear idea about the effectiveness of the e-learning courses, indicating the importance of LMS in e-learning. Naidu (2006) concurs with this importance, stating that LMS saves time and costs.

LMS provide administrative tools, collaboration and communications tools and assessment tools. Administrative tools include, for example, integrated registration, where administrators and/or instructors register new users and learners and e-learners can self-register if available. These tools are used to add or drop e-learners to and from online courses.

Authorise courses: this function is used to give specific access permission to course content and tools based on specific user responsibilities. Moreover, as part of the administrative tools, it allows the administrator and instructors to authorise courses.
One of the main administrative tools in LMS is the "set operations" which generates and allows accounts and new users to register in courses automatically. Moreover, the user-tracking aspects enable users to track their progress on course materials their results in assessments and provide analysis and reports about their usage.

LMS also provides collaboration and communications tools, which assist with users' engagement, collaboration and interaction in or out of the classroom by providing the most comprehensive communication tools for supporting their learning, such as forums, file exchange, internal messages, notes, chat and video-conferencing. Collaborative learning tools include Internet technologies, which support learning through the exchange and sharing of information and knowledge among learners (Horton, 2000, 2001).

LMS allows for customisation through which users can customise their course experience and teachers can teach the way they want to teach. Themes, which are flexible and customisable, and the ability to use different languages and switch between languages as required are examples. Moreover, other LMS learning objects can be imported.

LMS uses assessment tools to provide teachers with facilities to assess e-learners based on multi-type tests and exams, to track achievements in those exams and tests and to provide online grade books. This can be incorporated into an automated system by having a question bank that can randomise questions and tests based on a given complexity level.

In concluding this part, it is important to note that LMS targets the instructors and administrators and, in the case of institutions, training managers. Therefore, LMS provides primary management to the learners, and the main aim is to report learning results, and provide means of collaboration, gather user profile data, administrate and create tests.

According to Dunne & Butler (2004), different products of LMS are obtainable in the market; all share the same basic concept but structures and features differ slightly. The following table provides a list of some of the LMS currently available.

Table 3. 5: Some of the available LMS

Docebo	http://www.docebo.org/doceboCms/	Open source and free
Dokeos	http://www.dokeos.com/	Open source and free
ILIAS	http://www.ilias.de/docu/	Open source and free
OLAT	http://www.olat.org/website/en/html/index.html	Open source and free
Sakai	http://sakaiproject.org/	Open source and free
Ganesha	http://www.anemalab.org/	Open source and free
Desire2Learn	http://www.desire2learn.com/	Commercial
Joomla LMS	http://www.joomlalms.com/	Commercial
Saba LMS	http://www.saba.com/products/	Commercial

3.5.4.2. Learning Content Management Systems (LCMS)

According to Spector et al. (2008), a learning content management system (LCMS) is "*a multi-user environment where learning developers can create, store, reuse, manage, and deliver digital learning objects/content from a central repository*". The need for LCMS came into existence with the huge increase in the number of LOs and the need to manage and restore them in an efficient way. LCMS give the ability to perform an advanced search of LOs, advanced content management, produce and create distinctive descriptions for each LO, deliver various hierarchies for organising and storing LO, and enable the gathering together of compound course structures (Fallon & Brown, 2003).

Concluding this part, LCMS provide built-in authoring tools to create courseware learning objects, an effective method of using and reusing content across all courses. The primary target users of LCMS are the content developers, instructional designers and project managers, as they organise and assemble the LO which will be published and delivered in courses at a later stage (Liu et al., 2006). LCMS provides learner collaboration, and the ability to organise reusable content, use navigational controls to deliver content, and create and administrate tests (Loré Consulting, 2001). LCMS can handle different kinds of learning objects, such as PowerPoint slides, video/sound clips, online modules, HTML pages, images and illustrations (Loré Consulting, 2001).

Because of the facilities and capabilities provided by LCMS, such systems have become very popular. LCMS vary based on customer needs; some are adapted to specific platforms while others are designed for large-scale use. There are different firms and bodies who contribute towards the development of LCMS; some are commercial and others are free of charge and open source. The following table shows some of the LCMS available:

Table 3. 6: Some of the available LCMS

Out start LCMS	www.outstart.com	Commercial
XYLEME LCMS	http://www.xyleme.com/	Commercial
Moodle	www.moodle.org	Open source and free
Open Elms	http://www.openelms.org/	Open source and free
Atutor	www.atutor.ca	Open source and free
Blackboard	http://www.blackboard.com/	Commercial
TopClass	http://www.wbtsystems.com/	Commercial

3.6. E-LEARNING AND DEAFNESS

In this section, some of the efforts in terms of educating deaf people using ICT and e-learning are discussed.

3.6.1. Educating deaf people in Jordan using ICT

SignWriting Project in Jordan

Educating deaf children in Jordan and the Arab region in general is a relatively new endeavour. According to Abu Shaira (2007) there are no resources that discuss the education of deaf children in Jordan in Arabic or English.

Abu Shaira states (2007, p 9) that: "*The topic of teaching the deaf is new and the idea is not one that is Arabic, in origin. Therefore, there is nothing available which discusses this topic in the Arabic literature, new or old*". Abu Shaira's work is based on the use of the Sign Writing to improve deaf children's achievements at the fifth grade in Jordan (Khwaldeh, Shah & Ahmad, 2011).

E-exams and e-learning modules of tutorial lessons for the deaf student's software

According to Khwaldeh, Shah & Ahmed (2011) there was an attempt in Jordan to help the education of deaf children. Several e-systems were proposed by Al-Bayati and Hussein (2008) such as generic e-Exam package software for hearing impaired persons and Hussein & Al-Nisour (2009) proposed the e-learning modules of tutorial lessons for the deaf students.

The e-exam designed author modules for teachers of deaf pupils with two interfaces. The first interface used by the teachers and the other interface used by the deaf pupils. However, according to Khwaldeh, Shah & Ahmed (2011) such projects lack so many e-learning environment and LMS aspects such as:

- Both systems are standalone platforms and not integrated within a Learning Management System (LMS) and an e-learning environment. Such systems do not adhere and comply with the standards & specifications compliance for e-learning

systems such as SCROM, AICC and IMS global. This results in difficulties in importing/exporting learning materials from/to other systems. This is called the interoperability of a system. According to Al-Dahoud, Walkowiak, & Woda (2008) the interoperability affects the dependability of e-learning systems.

- The e-exam system lacks interactivity because it does not support and provide immediate feedback to the users (there is no interactivity among the users). An example is the system proposed by Al-Bayati & Hussein (2009). The e-exam system provides limited assessment tools such as multiple choices and matching words in two columns, Yes or No questions, fill in blanks and questions with one word answers compared to other assessment authoring tools such as the Articulate Quiz Maker (http://www.articulate.com/products/quizmaker.php) and Wondershare Quiz Creator (http://www.sameshow.com/quiz-creator.html).
- Both systems suffer from issues such as functionality and usability since they have been used and tested outside the Jordanian context. The e-exam system developed by Al-Bayati & Hussein (2008) has been tested with Indian sign language which is entirely different from the Jordanian Sign Language. The e-learning modules system developed by Hussein & Al-Nisour (2009) has been tested using the English sign language which is distinctly different from the Jordanian Sign Language. These systems and other similar systems will not be usable within the Jordanian context due to usability and diversity. Therefore, according to Al-Dahoud et al (2008), such systems will lack usability and availability which impact on the dependability aspects of e-learning systems.
- Both systems do not support and sustain collaboration and communication tools which allow the interactivity amongst users of both systems. Collaboration and communication tools such as chatting, forums and live videoconferencing are important to support more collaborative learning environments.
- It is necessary to note that none of the systems proposed by Al-Bayati & Hussein (2008) and Hussein & Al-Nisour (2009) supports the expansion and development of the e-learning system infrastructure. The scalability of an e-learning system requires the infrastructure of e-learning system to be flexible enough to support future system developments in terms of learning materials' size and number of users. Therefore,

according to Al-Dahoud et al (2008), the scalability affects dependability of e-learning systems.

- Finally, other dependability aspects mentioned by Al-Dahoud et al (2008) such as the stability and security of the systems proposed by Al-Bayati & Hussein (2008) and Hussein & Al-Nisour (2009) need further consideration and investigation.

With the very little literature available about educating deaf children in Jordan and the Arab world in general is relatively new. Therefore, statistical information about deaf people in the Arab region including Jordan is extremely limited (AL-Ja'am et al, 2008). However, this research project has attempted to shed light on the situation in Jordan.

3.6.2. Educating Deaf people in the Arab Countries using ICT

In the Arab region, the situation is totally different compared to the rest of the world because only a few projects have been undertaken to help educate deaf people in the Arab region. The projects were conducted in several countries such as King Saud University project which was launched for developing Arabic Sign Languages educational tool in Saudi Arabia (Al- Salman & Al-Khalifa, 2003), the work of Jemni and Elghoul (2007a) in Tunisia, the work of Khwaldeh, Matar and Huniti (2007) in Jordan.

Jemni and Elghoul (2007a) developed Web Sign software, which is a web based tool that translates text to sign language. They then designed an avatar that generates signs in 3D animations (Jemni and Elghoul, 2007b). The main objective of this research was to develop a tool that facilitates communication amongst deaf people and with hearing people. They used the same web tool to create online courses for deaf. The courses were based on aspects using a combination of the written sign language, videos and avatar technology. However, this tool, due to the French influence in Tunisia, used the French sign language as a key reference for translation. In conclusion, the tool used to translate from text to sign language mainly focused on the language itself. Moreover, there is no indication about using the system in delivering learning materials.

Mohandas (2006) introduced an ICT tool which translates Arabic text to Arabic Sign Language automatically. It aims to help deaf and hard hearing people to communicate with other hearing people. This tool is part of King Fahd University of Petroleum and Minerals

in Saudi Arabia to teach deaf people and other interested persons Arabic Sign Language. However, this project came to an end because of the lack of support and access to most of the deaf people in the Arab world. The project website address was (http://naas.itc.kfupm.edu.sa:8080/SignsApp/). However, it is not available anymore.

The Mohandes (2006) system used all gestures and signs of the Arabic Sign Language dictionary and stored it in a database. It showed each word and its similarity in Arabic Sign Language in video format (about 1300). If there is no translation for such word, the system will divide the word and finger spell it and show such word by its characters. However, this action encountered problems with the Internet connections and speed since at that time most users used dial-up connections (Mohandes, 2006).

Halawani (2008) proposed a system to translates text to Arabic Sign Language using PDA's and mobile devices. The main goal was to provide more accessibility for the deaf and hard of hearing people in the arab world. The system provides translation to the desired word using the avatar and the 3D technology. However, because the system runs on PDA's and mobile devices, this system is considered as a portable translator.

This system suffers from reliability issues since such devices are not accessible and available to a wide range of deaf users due to the high cost of obtaining such equipment. Moreover, these system requires continuous internet connection through the 3G mobile networks or WIFI which adds extra cost. More importantly, there is no evidence that such a system has been used.

Al-Khalifa (2010a) proposed a similar system which offers the same services to help deaf people in the Arab world. The only difference between them is that Al-Khalifa's system does not require a connection to the web server and the internet. However, Al-Khalifa's proposed system assumes that all the deaf and regular users know how to install it on their devices such as PDA's. Moreover, Al-Khalifa listed some of the limitations of the system such as the limited number of characters allowed into the translated words and sentences (only 50 characters), the limitation in the dictionary, the sentence semantics and word vowels.

Abo El-Soud, Hassan, Kandil, & Shohieb (2010) proposed an e-learning system that offers a dictionary to deaf users. The system consisted of two parts. The first part is considered as the main e-learning platform. It consists of the following: the "*user interface"* which is the main gate to access the internet. The deaf user enters the URL, and then the interface will pass the URL to the "*Web page scanner"* that will scan and examine the desired page and pass the results to the "*Content Generator"*.

The "C*ontent Generator"* is divided into various parts. The first part is the "*Web page content extractor"* extracts the Arabic content in the desired web page and the second part, "*Web Tags Filter"* purifies the content and eliminates all tags of the desired web page. The "*Content Generator"* passes the filtered webpage to the "*Arabic Sign Language Converter"* to translate the web page content using the "*Arabic Sign Language library"* containing approximately 3500 Arabic gestures. The returned values are sent to the "*Arabic Sign Language format generator"* that produces the desired output and formulates it in two ways. Firstly, it generates photos using the "*Photo album generator"* or through the second way, which shows the output in the form of written lines of sign language using the "*written sign language line-by-line generator"*.

The systems proposed by Mohandes (2006), Jemni and Elghoul (2007 a&b), Halawani (2008), Al-Khalifa (2010a) and Abo El-Soud et al (2010) cannot distinguish between similar words in Arabic which have different meanings, which results in difficulties for the deaf users. For example, the word (Thahab "ذَهَبَ") means "went or gone", on the other hand, another word with the same character's (Thahab "ذَهبْ") means "gold". Moreover, such systems ignore the fact that users might use the informal Arabic (Colloquial or dialectal Arabic), which differs from one Arab country to another. For example, the Car is called in Egypt (Arrabyah "عربيه") while in Jordan and other Arab countries as (Sayarh "سياره"). It is well known that all Arab countries use their colloquial or dialectal Arabic in daily life (in markets, conversations and chatting and exchanging mobile messages). Therefore, it is difficult to apply what works in Egypt to Jordan and vice-versa.

One of the disadvantages of Halawani (2008) and Al-Khalifa (2010a) systems is that they need to be installed on mobile devices ignoring which run different operating systems such

as Android™, IPhone OS™, Symbian™ and Wondows Mobile™, which require different procedures and programming.

Finally, it is essential that there are some personal efforts conducted by teachers of the deaf to use available ICT such as Microsoft PowerPoint™ to support the learning environment of deaf people in Jordan.

3.6.3. Educating Deaf people in the rest of the World using ICT

On an international level, the only e-learning platform that has targeted deaf children to deliver mathematics and science was the SMILE (Science and Math in an Immersive Learning Environment) project. SMILE aims to create an intuitive and natural interface for navigation, interaction, and input/recognition of American Sign Language (ASL) math signs in immersive Virtual Learning Environments (VLE) for the Deaf (Adamo-Villani, Heisler, & Arns, 2007). The content of this virtual learning environment is based on the standard elementary school curriculum. The VLE uses spoken and written English, and American Sign Language.

According to Mich (2008), SMILE is "*the first bilingual VLE for deaf and hearing students proposing learning activities that are grounded in research on effective pedagogy*". Moreover, The SMILE uses 3D avatars technology. However, according to Mich (2008) the SMILE is not a web-based tool and suffers from navigability issues.

The suitability of adapting SMILE within the Jordanian context is questionable due to the signing diversity, the difference in using a second language (American English in the case of SMILE) instead of Arabic. In addition to the difference in the national curriculum which means different content.

Other projects targeted deaf people with the aim of providing electronic sign language dictionaries. Such projects have been undertaken primarily in the in United States, UK and some other countries in Europe such as the Dictionary of British Sign Language / English (Brien & Brennan, 1992) and Multimedia dictionary of American Sign Language (Wilcox *et al*, 1994).

A third group of projects targeted the deaf adults but not deaf children such as BITEMA and DELFE projects. The *BITEMA project* aims to "*develop improved methods and means of education for deaf adults who cannot access the labour market due to poor school knowledge and poor qualifications on the whole*" (Debevc, 2003). To achieve this, pedagogical methods were used with main focus on visual resources such as video recording of sign language, the use of animations, CD\DVD- ROM and the use of 3-dimensional animations. Moreover, there is a focus on the development of natural language learning.

DELFE project is an abbreviation, which stands for *Distance and Life Long Training for the Deaf people in the E-Commerce and New Technologies Sector via e-Learning Tools*. According to Drigas & Kouremenos (2005a), DELFE Project aims to "*create a passage for deaf individuals into the new professional fields via their training with specialised knowledge and dexterities in the use of the continuously developing sectors of e-learning and electronic Trade (e-commerce)*".

DELFE project use advanced teleconference services of the Internet within an e-learning environment for the deaf via the sign language. DELFE project utilised animations and Adobe Flash technology to provide and develop informative and e-learning materials in the form of electronic materials. Moreover, the DELFE project used the Greek sign language glossary in video format, a translation of the content in Greek sign language and special virtual classrooms (Mela, 2007).
In Germany and Similar to the Greek DELFE project, there was the AILB project. The main aim of this project was to create a Learning Management System (LMS) to provide German Sign Language (GSL) in parallel to every learning material within the learning environment (Mela, 2007).

Michaud, McCoy, & Pennington (2000) implemented an intelligent tutoring system with the aims to improve literacy in deaf high schools and college students who use the American Sign Language (ASL). According to Michaud et al (2000) the focus was on the approach used to solve the problems of English literacy among deaf students using a tutorial tool. This tool aims to supplement English literacy classes by providing feedback on any grammatical errors and at the same time keeping records about students acquisition.

Bueno, Castillo, Garcia, & Borrego (2007) focused on problems facing deaf pupils with reading comprehension and competency. Bueno et al (2007) used a computerised software to teach deaf pupils four groups of words consisting of English words, technical words used in computer science, terms used in common use and terms used in computer science context.

The DEDALOS project promoted English as a second language for deaf people in Greece. Using a remote linguistic training software that use an e-learning environment for the deaf. In this project and as its relation to DELFE project, all learning materials has been created and adapted and translated to the Greek sign language and presented as video streaming (Drigas, Vrettaros, & Kouremenos, 2004b).

The ITOM project based in Holland, ITOM project form as a part of the sign language Europe project. ITOM project provides learning materials (mainly videos) and makes them accessible through Dutch by sound and subtitles and Dutch Sign Language (DSL) by School-TV broadcasting (Mela, 2007).

The ELGE Project is based in Austria developed an e-learning system for deaf and hard of hearing people in Austria. ELGE stands for E-Learning for hearing impaired and deaf people. This project started in 2007 and finished in 2009. The outcome of this project was a Demo or prototype of an online system for the deaf. One of the uniqueness of this project was giving the deaf people the opportunity to generate, produce and publish contents. The generated content comes in the form of recorded materials in video format. The content has been shared among the deaf community in Austria using the Internet and other medium such as CDs and DVDs. (ELGE, 2009).

Several studies have been conducted to teach deaf people using e-learning systems in different parts of the world such as the work of Straetz et al (2004) in Germany; the work of Drigas, et al (2004a, b; 2005a, b) in Greece and the work of Efthimiou, Fotinea, & Sapountzaki (2006) in Greece.

Other projects have been aiming at improving the language of the country for deaf individuals such as the three projects in Italy, named *Articoli*, *Carotino* and *Pro-Peanuts.* They were developed to overcome specific problems with verbal Italian grammar for Italian users (Mich, 2008).

LODE (LOgic-based e-tool for DEaf children) Project, is an e-learning system aims to develop deaf people aptitude to understand written texts in Italian. LODE was a PhD project conducted by Mich from 2007-2009. According to Gennari & Mich (2007), less deliberation was given to the development of e-learning tools that work on improving the literacy of deaf people in spoken languages (verbal). LODE focused on by providing deaf children with stories in electronic format and then the user can choose stories to view.

In conclusion, very little attention seems to have been devoted to the development of e-learning platforms for improving the mathematical skills of deaf children. Considerably more attention has been devoted to the development of the Sign language and the language of the countries that the deaf person belongs to and stays within. Moreover, such projects are targeting deaf adults generally. Due to the signing diversity, it is difficult to make use of the above or any other systems within the Arab context and for mathematics education in particular.

3.7. CURRENT AND FUTURE TRENDS IN E-LEARNING

E-learning has evolved and expanded in different directions with the growth of technology. It has become mobilised, with the production of new and enhanced mobile handsets, and the Internet, speed and bandwidth. The improvement in mobile handsets industry came in the form of PDAs and lately, the netbook and tablets, such as iPhones and iPad's from Apple, and those of other vendors.

The use of the iPad in e-learning will boost and open another portal as it is connected to the Internet through Wi-Fi or 3G (third generation mobile networks). The iPad can be used for delivering the courseware, learning materials and learning objects integrated within LMS or LCMS.

Courses can be taken and viewed on the move, through PDF files and other learning objects. Moreover, instructors can create and upload learning courses. This comes from the fact that such devices have the ability to browse the Internet because they are equipped with browsers.

Based on the current speed of expansion in the use of these mobile devices, it is expected that such devices will be used to access e-learning platforms similarly to computers. This will require developing e-learning to adapt to the new trend and start developing portals for these devices and find ways to integrate them into e-learning schemes in terms of functionality, design and features.

Another trend is the expansion of social networks and their impact on future social learning. This could be incorporated and used in e-learning through the interactive and collaborative tools offered by these networks. The social networks such as Facebook, Twitter and others are used by millions of people all over the world and form an ideal place to upload and share learning materials; the learning objects uploaded by the users could be videos/sound files, text, or images. This will make another portal for e-learning.

3.8. SUMMARY

This chapter has presented the learning concepts, definitions and relationships to education and training. Learning theories and their implications in the e-learning field were presented and discussed. A historical perspective was presented of the use of ICT in education. The terminologies of recent technology-based or enhanced learning, such as online learning, web-based learning, etc. were also discussed and highlighted. The term e-learning and its definitions and classifications were presented, and three e-learning components were proposed. E-learning systems, such as LMS and LCMS were described and, finally, the last section presented and predicted some of the trends in e-learning expected to evolve in the near future.

The next chapter of this thesis, discusses the methodologies used in this research, the employed research tools and instruments, the choice of specific techniques, data analysis, ethical issues addressed in this research.

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

This chapter discusses and describes the research methodologies used to carry out this study. To gain an understanding of the research topic and validate the findings with data, a combination of qualitative and quantitative research was used. For the qualitative data collection and analysis, the researcher used interviews, literature and observation. For the quantitative, the questionnaire method was used. Whilst this chapter provides an overview of the methodological approaches used, the following chapters will provide more detail.

Kerlinger (1964), states that no method of research or analysis is perfect, and each has its benefits and disadvantages. Therefore, researchers should choose the method that seems most suited to their own research problem and data. Researchers need to study, understand, use and interpret such methods and handle the results with care. In order to pursue the objectives of this study, a research design was developed taking the following into consideration.

4.2 METHODOLOGIES EMPLOYED

A combination of two research methodologies used in this research, Action Research and Human-Computer Interaction (HCI) related research methods (such as observation of users and tracking their interaction behaviour), Due to the interdisciplinary nature of this research, it was essential to use a hybrid research methodology. The justification for this is as follows:

According to Hussey & Hussey (1997), action research assumes that "*the social world is constantly changing, and the researcher and the research itself are part of this change"*. Meanwhile, Bryman (2004) defines action research as *"an approach in which the action researcher and a client collaborate in the diagnosis of a problem and in the development of a solution based on the diagnosis"*. Thus, the researcher has participated in the process of

research by diagnosing the problem and providing the solution and corroborating with users in modernising the problem and proposing a solution based on that diagnosis (Bryman, 2004). Action research is felt to be an appropriate methodology for this study as improvements are being sought in the level of achievement of deaf children, through an interactive process between the researcher and the teachers.

Hussey & Hussey (1997) state that "*action research always involves two goals: solve a problem for the clients and contribute to science"* and that *"the researcher and the clients should learn from each other and develop their competence additionally they must cooperate, feedback to the parties involved and continually".* This implies that there must be continuous feedback between the researcher and teachers that will result, in this research, in improvements, in the education of deaf children. McNiff (2002) indicates that "*the methodology of action research is that people ask questions such as "how do I do this better?*". This is particularly apt for the research context..

Action research involves the collection of both quantitative and qualitative data. In order to learn how to swim, one's need to get into the water. Following this analogy, and the thoughts of Bryman (2004), the researcher must be immersed in the learning environment and participated in the research project with the aims to deliver and evaluate e-learning. According to Smith (2007) and Reed (2007), action research is a suitable research methodology for working on problems specific to the classroom and an educational context, as it can help to resolve teaching challenges (such as, in this research, teaching deaf pupils). Moreover, according to Elliot (1991), by its very nature, action research is a collaborative approach suited to research involving groups aimed at solving challenges and problems.

According to Baskerville (1999), in 1985, Wood-Harper was the first person to introduce action research as a research methodology in information systems research, with the "multi-view" concept that incorporated "*action research concepts into an action-based systems development methodology*".

The other methodology employed in this study, HCI, is "*a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them*" (Hewett et al, 1996). This implies

that HCI will be appropriate in the context of this research, which will involve the use and evaluation of e-learning and open source LMS by Jordanian deaf pupils and their teachers.

According to Roy, Dewit, & Aubert (2001), HCI is a very important element of the web environment. In the web-based learning and e-learning context, HCI is represented by the LMS interface. This is a very important component of e-learning as it forms the link between the users and the learning content and materials (Seok, 2009). This link allows users to access, use and manage the content through an interface (Ciavarelli, 2003; Harris, 1999).

According to Cox, Cairns, Thimbleby & Webb (2007), HCI is a multidisciplinary subject, addressing the issue of how users use computers or, in other words, the interaction between the users and the computer's user interface. From a historical perspective, HCI emerged from the two disciplines of psychology and computer science. However, HCI encompasses other fields, such as education, business, design and development, information technology and computing, library services and entertainment (Giacoppo, 2001). Cox et al. (2007) add philosophy, social sciences and cognitive ergonomics to the list of subjects included within the HCI methodology.

Triangulation

According to Hanson (2008) and Seok (2009), computers and other related technologies help deaf people to learn, due to the visual nature of the information presented on screen (online and offline), which promotes accessibility by meeting the specific needs of the users (in this context, deaf users). The importance of such technologies lies in providing deaf users and their teachers an appropriate display using the technologies available, such as audible signals, a multimedia interface (captioning and signing), input technologies (speech and sign interfaces) and others.

Shah (2002) defines the term triangulation as "*the process of combining different research methods or different data collection techniques to look at a problem from different points of view*", indicating that triangulation is an alternative to validation but is not a strategy or tool. Chaudire (2000) differentiates between four types of triangulation: methodological, investigator, theory and data.

In this research, two types of triangulation were used, data (the data collection instruments consisted of questionnaires, semi-structured interviews, web-based observation and pre- and post-testing of the deaf students); and methodological (HCI related research and action research).

The methodological triangulation in this research meant to be cover two aspects. The first aspect is that action research is most suitable for working on problems specific to the classroom and an educational context, as it can help to resolve teaching challenges. On the other hand, the using the HCI related research methods is to address the issue of how deaf pupils use the chosen LMS and what type of e-learning that suit them. Moreover, HCI used to evaluate the effectiveness, usefulness and friendliness of the LMS.

4.3 DATA COLLECTION TOOLS USED IN THIS RESEARCH

It is important to explain the data collection instruments that have been used within this research. As mentioned above, four data collection methods were used. According to Bryman (2004), using semi-structured interviews is one of the most prominent methods of data collection in this context; thus this method was considered crucial for this research. Additionally, observation through conducting tests and assessments can provide valuable data for action research (Kember, 2000). Thus, the pre- and post-test achievements of the children in mathematics were used as one of the main methods of data collection. Moreover, the use of questionnaires is very cost effective, and especially relevant in this case where a large geographic area needed to be covered (Bryman, 2004).

4.3.1. Choice of Specific Techniques

Reviewing the literature on research methodologies has revealed that most researchers in social science research use a variety of techniques to serve specific purposes, such as questionnaires, checklists, textbook analysis, observation and interviews. Many researchers use the questionnaire method to provide a relatively quick and valid overview of the field. The review showed that most of the questionnaires used by other investigators tend to be e-mailed or completed online, rather than being administrated in the presence of the researcher or with his/her assistance. As a result, it is hard to take some of the research

findings seriously, because the respondents might not have properly understood the content of the questionnaires. Conducting this research within the Jordanian context gave the researcher the opportunity to address this point through personal contact with the teachers. This enabled the researcher to listen to their opinions on deaf education and hear their experiences of teaching deaf children. The four main data collection methods used are described in detail below.

4.3.1.1 Interviews

According to Denzin & Lincoln (1998), interviews are the data collection tools most frequently used for collecting qualitative data. Interviews allow the researcher to discover the interpretations of the interviewees regarding specific topics and events that have occurred or are still occurring (Walsham, 1995). They allow the researcher to question and investigate the problem more deeply and highlight new evidence (Shah, 2002). This enables the researcher to gain a better understanding of the problem from the participants' points of view. Rubin and Rubin (2004) state that "*any verbal confirmation or dis-confirmation of observation or any formal, informal or casual answers to a question constitutes an interview*".

Interviews are used to collect information from informed personnel, such as teachers, inspectors and administrators. With regard to the selection of the interviewees, one criterion is the extent to which the professional competence, value and integrity of the interviewee is fully recognised in academic circles related to the area in question. Opdenakker (2006) states that interviews may be conducted in different modes, including face-to-face interviews, telephone interviews and Computer Mediated Communication (CMC) using the Internet, for example, e-mail interviews, chat interviews with/without voice (e.g., MSN, Skype and Yahoo Messenger). However, each method has its advantages and disadvantages.

The face-to-face interview is one of the most common and well-known methods of interviewing. It allows the interviewer to monitor the interviewee's social signals, such as a change in the tone of voice, facial expressions and body language. In terms of

communication, face-to-face interviews fall under the category of synchronous communication of both time and place (Opdenakker, 2006).

Interviews can also be categorised as structured, semi-structured or unstructured. The type of interview used will determine the nature and amount of information gathered. According to May (2001), the use of structured interviews helps to expose the participants' opinions, attitudes and feelings towards a specific topic or problem. On the other hand, unstructured interviews help to gather participants' opinions in relation to other topics outside of the main focus being investigated. Semi-Structured interviews have been used in this research.

Semi-structured interviews are often used for their flexibility during the interview, as they allow new questions to be introduced as needed. Lindlof & Taylor (2002) emphasise the importance of preparing an interview note or guide of the topics that the interviewer wishes to discuss in the interview. This will help the researcher to control the interview, maintain focus on the key purpose, and stay within certain boundaries in order to gain the most from the interview. Based on this interview notes were prepared, see Appendix A (1).

The semi-structured interviews and the questionnaires were used for the purpose of discovering the current level and state of use of ICT, e-learning environments and LMS in Jordanian classrooms, as well as to understand the problems facing deaf children in Jordan in learning some specific areas of mathematics.

Using semi-structured interviews in this research enabled the researcher to ask a variety of questions and allowed teachers to provide the researcher with their ideas for helping deaf children and improving their academic performance. This facilitated the researcher's understanding of the teachers' perspectives. Moreover, this led the researcher to ascertain the current level of achievement and learn about any additional tools that were been used All of the interviews were conversational in style with the purpose of allowing teachers to express their own personal views on effective e-learning experiences.

It is important to note that the semi-structured interviews were used primarily in this research to develop an understanding of the present educational system and the factors that may encourage or discourage children and teachers from using e-learning as an

instructional method. During this period, the researcher also familiarised himself with the classroom environment, by attending some classes in two of the schools.

The planning process for the action research semi-structured interviews with teachers to understand from their perspective the problem, this was important because of their experience with the educational problems, and mathematical problems in particular, facing deaf children. Gaining an understanding of the main problems that deaf children face when learning mathematics and by reflecting on this, the researcher purposed and introduced the evaluated e-learning environment. In later stage, the researcher used the semi-structured interviews to gain an understanding about teachers perceptions about them and their deaf pupils using the adopted open source LMS. The semi-structured interviews were used in two occasions in this research. The following table gives details:

Table 4. 1: Semi-structured interviews use in this research

Type	Number of participants	Type
1st Semi-structured Interviews	15	Face-Face
2nd Semi-structured Interviews	6	Telphone

4.3.1.2 Questionnaires

Questionnaires are usually employed in situations where the researcher needs answers to a variety of questions from a considerable number of subjects. Despite the reservations and criticisms of educators such as Walonick (1993), one can say that questionnaires remain a useful and constructive tool in any research concerned with human issues, such as eliciting attitudes, values, feelings and retrospective motives for acting in certain ways, etc. The questionnaire is capable of eliciting a large quantity of data about a large number of people in a short time and at a lower cost than other techniques such as interviews. Moreover, because of the standardised format, it lends itself very well to computer analysis, which makes the analysis more accurate and convenient. The main disadvantage of this technique is its indirectness. Nevertheless, if a questionnaire is carefully designed, carefully used and preferably complemented with other appropriate techniques, such as interviews and observation, it can be both an effective and efficient tool for gathering information.

In this study, the researcher used two different questionnaires for two purposes. The first was to develop an understanding of the current use of e-learning environments and LMS

within Jordanian schools for the deaf and any additional tools that are used. The second was to evaluate the effectiveness of the e-learning environment and LMS from the teachers' perspective. Having gained feedback from all participating schools, the researcher incorporated their suggestions into the analysis and for future work. For questionnaires used in this research see appendix B.

The original versions of the two questionnaires were written in English and then translated into Arabic by the researcher. They were prepared in a hard copy format and distributed by hand. The questionnaires were filled in in the presence of the researcher so that he was able to answer participants' questions. This medium was used to distribute the questionnaire as electronic and web formats would have required special consideration of the software packages and websites that the respondents had access to, in addition to adding to the researcher's financial costs. Moreover, using the conventional way of distributing the questionnaire helped the researcher to clarify elements of the questionnaire to the teachers and to take advantage of visiting the schools for conducting semi-structured interviews with some of the teachers at the same time. The questionnaire was used in two occasions in this research see table 4.2:

Table 4. 2: Questionnaires use in this research

Type	Number of participants	Type
1st Questionnaire	65	Face-Face
2nd Questionnaire	10	Handed by hand and received by e-mails

4.3.1.3 Pre-Test and Post-Test

According to Elsendoom (1998), when evaluating an e-learning environment for the deaf, there are two aspects of evolution we need to look at –friendliness and the effectiveness of the e-learning environment. Elsendoom states that the effectiveness of the e-learning environment can be tested in two different ways – within-group or between-group.

The within-group design assumes that users will be given a formal test before using e-learning and LMS and will then be tested again, after using them. Any gains in performance through the use of the tools over a given period of time will then be measured (Lazar, Feng, & Hochheiser, 2010). In other words, the difference between the two tests, if any exists, will give an indication of the effectiveness of e-learning and LMS. On the other

hand, the between-group design is used to compare one e-learning environment with another or with conventional methods of teaching or training (Lazar, Feng, & Hochheiser, 2010).

In their text, *Research Methods in Human-Computer Interaction*, Lazar, Feng, & Hochheiser (2009) indicate the advantages and disadvantages of using the within-group design. On the positive side, the use of a within-group design reduces the sample size which is important as in some HCI studies it is hard to recruit participants. Moreover, the within-group design eliminates individual differences between participants (Lazar, Feng, & Hochheiser, 2010).

The choice of design was determined by the level of participation and the participants. In this research, where deaf children are using an e-learning environment and LMS, the researcher compared class test results in mathematics before the intervention (pre-test results) with those gained after using e-learning and LMS (post-test results). The effectiveness of the e-learning and LMS was thus measured based on Elsendoom's (1998) within-group design.

Each semester the children have three mathematics tests. The effectiveness of the e-learning environment was judged by monitoring the pre/post-test results.

4.3.1.4 Observation

Observation was used in this study to gain a greater understanding of the problem. Brown (2004) considers the findings from "an observational research strong in validity". Morris (1973) defines observation as "the act of noting a phenomenon, often with the instrument and recording it for scientific or other purpose". Based on this and applying it to the context of this research, the researcher observed the deaf pupils and their teachers while they were using the LMS and e-learning. In this context, the observation led to a better understanding of what was used and what was not by the pupils and teachers when they accessed the learning content, communication and collaborative tools offered by the LMS.

In a conventional observation, all the senses can be involved, including hearing, seeing and touching, for example (Choudrie, 2000). Therefore, all kinds of data can be gathered by

observation and used to describe settings, activities and meanings from the perspective of the participants (Patton, 1990). It is important to note that observation has both advantages and disadvantages. Brown (2004) indicates that observations are flexible in nature and do not necessarily need to be structured. However, questions the reliability and generalisability of observations. Moreover, Shah (2002) indicates that, during observation, the observer might be biased and may introduce a distortion into the scene (i.e., they see what they want to see). However, Brown (2004) says that this problem can be overcome through training and electronically recording observations.

In his text, *The complete observer?*, Sanger (1996) states that observational research can be conducted in a technological sense through the use of "*electronic eyes and ears*", meaning video-recording the scene to gain the maximum amount of information. However, this too has certain drawbacks. For example, if it is done with the participants' awareness it is considered as a direct observation, it may be problematic due to the Hawthorne Effect. On the other hand, if it is done without the participants' awareness, it is considered as an unobtrusive observation, there are ethical issues such as invading the privacy of the participants (Brown, 2004). According to Brown (2004), direct observation has two common types: continuous monitoring (CM) and time allocation. Unobtrusive observation can also be divided into two types: behaviour trace studies and disguised field observations.

According to Sanger (1996), observation counts is one of the most common methods of collecting data, involving counting the number of occurrences of a given act or scene during an observation period. Such data can be very interesting and challenging. Within an educational context, such a method could be used effectively by designing a check list to include all the actions to be observed within the classroom, such as how many times the teachers talk or sign, how many times a student asks a question or participates in the class or how many questions are asked during the class.

In this research context, observation was used to gain a deeper understanding of the pupils' and teachers' use of e-learning and the LMS. However, the researcher faced major problems with this as the participating schools were located in different geographical areas approximately 200-250 kilometres apart, which would have made it both costly and time-consuming to be physically present in both schools. It would also have been impossible for

the researcher to observe the users during their asynchronous access to the learning content (e.g. while they were at home).

In order to solve this issue, the researcher used the tracking system built into the LMS to track and observe the users' activities when they were accessing the learning materials and content (web-based observation). This method of observation allowed the researcher 24/7 observation of the use of the system. Moreover, it provided important information about the use of the LMS, through generated statistical information regarding access to the LMS and its learning materials.

4.3.2. Piloting the Questionnaires and Interviews

According to Polit et al. (2001), in social science research a pilot study can be used in two different ways: "*small scale version, or trial run, done in preparation for the major study*". Baker (1994) states that pilot studies meant to be the pre-testing of a specific research tool. Oppenheim (1992) emphasise the importance of pre-testing questionnaires before the final draft is administered. Therefore, two pilot studies were conducted to test the two data collection instruments (both questionnaires and the semi-structured interviews).

A pilot study was conducted to evaluate the questionnaires and the semi-structred interviews reliability, credibility, clarity and the time required for their administration. Moreover, piloting the questionnaires allowed the researcher to detect any weaknesses and shortcomings in their design and administration. The main idea is to avoid misunderstandings or ambiguities (Shah, 2002).

The pilot study was conducted on teachers working in two of the MOE schools for special needs and disabled people in the Al-Balaqa and Al-Karak districts. An approval letter was acquired from the MOE in Jordan prior to the start of the study. Discussing the significance and importance of this research and its impact on the education of deaf pupils in Jordan with the headmasters paved the way for the conducting of these pilots in their schools. During the meetings with the participants, the researcher explained the purpose of the research and the pilot study, and encouraged the teachers to criticise the questionnaires and the semi-structured interviews and suggest any changes that would improve their structure or design.

Enough time was given to each of the participants to respond to the questions and for the researcher to write down their comments and make notes. The total number of respondents was thirty teachers for the questionnaire pilot study and two for the pilot of the semi-structured interviews. The questionnaires and semi-structured interviews were piloted in two occasions in this research see table 4.3:

Table 4. 3: Questionnaires and Semi-structured interviews in pilot studies

Type	Number of participants	Type
1st Questionnaire	30	Face-Face
2nd Questionnaire	4	Face-Face
1stSemi-structured Interview	2	Face-Face
2nd Semi-structured Interview	4	Face-Face

4.4 EVALUATION OF FOUR LMS

In this part, the researcher evaluated four open source LMS for the aim of adopting one of these LMS's based on the recommendations and requirements of the users. The four open source LMS that were chosen were Moodle, Sakai, OLAT and ILIAS. The aspects been evaluated and the methodological approach used in this evaluation is described in much detail in chapter 6.

4.5 ETHICAL ISSUES

The ethical issues are discussed in this thesis in chapter 5 and 7. The ethical issues were the participants and participation, potential risks to the participants, potential risks to the researcher. Moreover, the researcher described the steps of obtaining genuine consent of participation from the teachers, parents/guardians and the deaf pupils.

The researcher followed the recommendations and guidelines of Priscilla Alderson in seeking participation of the teachers and their deaf pupils. The procedures are discussed in more details in chapter 7. Moreover, the researcher has addressed ethical consideration when conducting the semi-structured interviews. The procedures are discussed in more details in chapter 5.

4.6 DATA ANALYSIS

In terms of conducting this study, the data were derived from different sources, such as books, conference papers, related journals, reports, official publications, periodicals, statistical yearbooks, unpublished materials in documents (online and offline), in English and Arabic languages. Qualitative data derived from the semi-structured interviews was analysed using the content analysis methodology (Krippendorff, 2004). Meanwhile, quantitative data analysis was used to extract descriptive statistics. After the data collection had been completed, data analysis was conducted using software called SPSS, which is used in the social sciences to generate cross-tabulation in order to demonstrate the combined distributions of variables in a contingency table in matrix format. Microsoft Excel was also used to generate percentages and charts.

The participating teachers and deaf pupils from participating schools for the deaf in Jordan in the academic year 2009-2010 were used as a data source to determine the current level of use of e-learning and LMS for the deaf within the Jordanian context. Data collection took place in the year 2010. A letter was obtained from the MOE in Jordan granting permission for the visit and access to all schools in Jordan, including schools for the deaf, allowing the researcher to meet teachers and collect the data needed for the research.

4.7 RESEARCH DESIGN

The following figure describes the research design and at what stage of the research data collection instrument used to collect data.

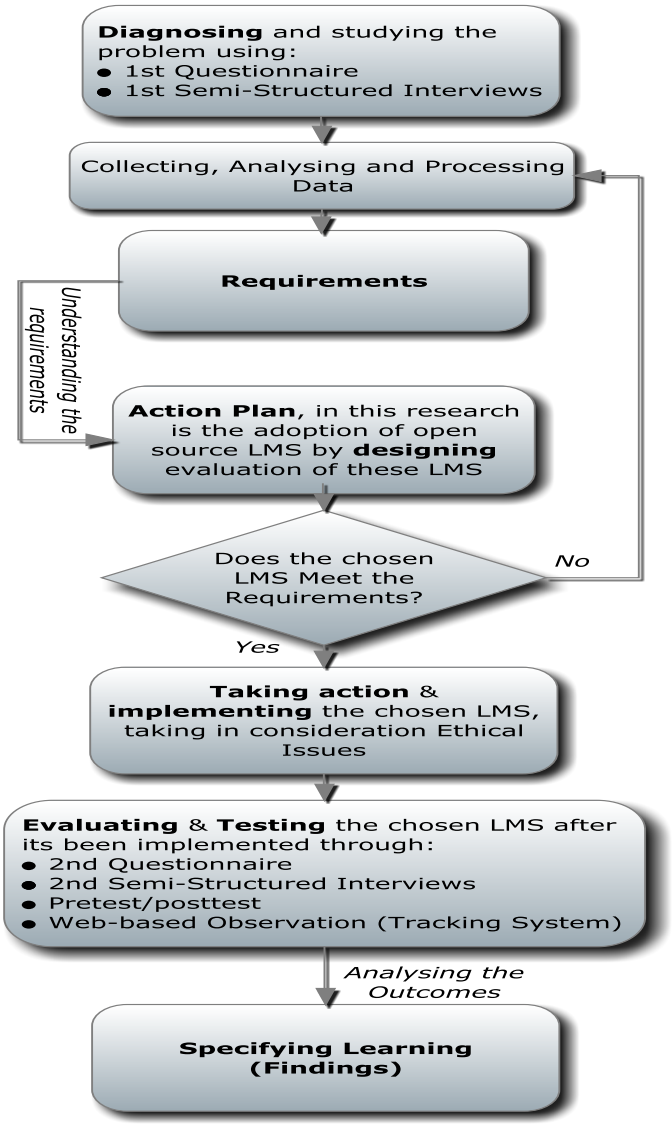


Figure 4.1: Research Design

4.8 SUMMARY

In this chapter, the methodologies used in this research, namely Action research and HCI have been described. A combined research methodology was used because of the interdisciplinary nature of this project. In order to understand the philosophical background of the research, a brief discussion of the chosen epistemologies and the rationale behind using them was provided; this helped the researcher and is also aimed at helping the reader to understand the context of this research.

Finally, the data gathering tools, questionnaires, interviews, observation and pre-/post-tests, were explained to show their suitability for the problems under study. The data analysis methods were discussed and will be discussed in more detail in the later chapters. In the following chapters, the findings from the data analysis will be presented.

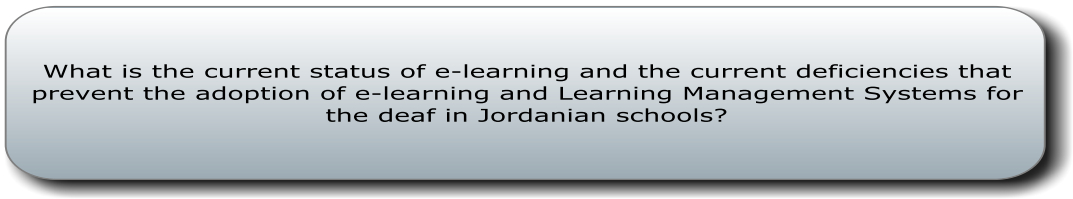
In the next chapter, the researcher will discuss the current status and use of e-learning and LMS within Jordanian schools for the deaf. This includes discussing the outcomes from conducting semi-structure interviews and questionnaires with the teachers.

CHAPTER 5

CURRENT STATUS AND USE OF E-LEARNING WITHIN JORDANIAN SCHOOLS FOR THE DEAF

5.1. INTRODUCTION

The literature review provided information about the current status of deaf education within the Jordanian context and the research that has been conducted towards helping deaf children, nationally and globally, improve their academic achievements. However, it is impossible for the results of such studies to be universally applicable as they have been conducted in different environments and countries and are aimed at different topics. For example, what applies in the UK and the US may not apply in Jordan and vice versa. Therefore, there was also a need to determine the current status of schools for deaf pupils in Jordan itself. The following research question emerged from the literature:



To answer this question, an inclusive investigation was conducted to discover the extent to which e-learning and LMS are used within Jordanian schools for the deaf and any barriers that in the teachers' opinions prevent the adoption of e-learning in these schools.

For this purpose, a survey was conducted and distributed to five schools for the deaf in Jordan.

The researcher also conducted semi-structured interviews with teachers of mathematics to find out about the main areas of mathematics that deaf pupils have problems with (within the target age group / school level) and the reasons for such problems.

The survey and interviews were conducted with the aim of gaining a clear understanding of the current level of use of e-learning and LMS, and teachers' thoughts on the barriers to their use within Jordanian schools for the deaf, filling a gap in literature and providing a

suitable solution, based on the responses of the teachers and their expectations about using e-learning and LMS.

The teachers, even though are not specialised maths teachers, all have mathematics knowledge and experience and the level of mathematics used in the study is very basic and therefore it appropriate to use these teachers. They have some background and knowledge of e-learning systems. Combining this expertise gives a good balance of e-learning with mathematics and deaf studies in the schools participating in this study. Very few teachers qualified in mathematics and with experience of deaf education are currently resident in Jordan and teaching in these schools.

The researcher lacked the communication language to talk directly to the students and the study measured the effectiveness of e-learning for study of mathematics with deaf students. This approach gave an impartial statistics of the effectiveness of the systems used.

5.2. METHODOLOGY

As stated above, various data collection methods were used in this study. At this stage, the questionnaire was used as the major means of data collection and complemented it with semi-structured interviews with teachers of mathematics. The questionnaire was employed as it was felt to be most appropriate given the size of the sample to be studied and the kind of data required from the respondents. Semi-structured interviews were used as an additional method to gain even more insight into the topics investigated. The intrinsic problems with such methods were kept in mind and every effort was made to ensure the design was relevant, including using a pilot study as well as appropriate implementation procedures.

It is important to note that some elements of this approach were based on questionnaires used by Thomas (2006) and Liaw, Huang, & Chen (2007). Based on these works, two sections of questions were asked:

- Personal/educational background, years of experience teaching deaf pupils and the number of subjects they are teaching.

- The teachers' ICT competences and the degree to which they employ it in their teaching, the availability and accessibility of ICT tools, infrastructure, LMS and e-learning platforms.

Based on above, the researcher developed ten hypotheses to test, based on the associations between questionnaire items.

- Is there an association between the ability of the teachers in using computers and the Internet (ICT skills) and their years of experience teaching deaf pupils? The hypothesis for this is: *there are no statistical differences at $\alpha \leq 0.05$ between teachers' use of ICT skills due to their years of experience of teaching deaf students.*
- Is there is an association between the teachers' ICT skills and their years of experience teaching mathematics to deaf pupils? Hypothesis: *there are no statistical differences at $\alpha \leq 0.05$ in teachers' use of ICT skills due to their years of experience of teaching mathematics to deaf pupils.*
- Is there is an association between teachers' ICT skills and the number of topics they teach? Hypothesis: *there are no statistical differences at $\alpha \leq 0.05$ in teachers' use of ICT skills due to the number of topics they teach.*
- Is there is an association between teachers' ICT skills and the number of topics taught by teachers of mathematics? Hypothesis: *there are no statistical differences at $\alpha \leq 0.05$ in mathematics teachers' use of ICT skills due to the number of topics they teach.*
- Is there is an association between teachers using e-learning in their teaching and the years of experience of teaching deaf pupils? Hypothesis: *there are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning due to the number of years of experience of teaching deaf students.*
- Is there is an association between teachers using e-learning in their teaching and the years of experience of teaching mathematics to deaf pupils? Hypothesis: *there are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning by mathematics teachers due to the number of years of experience of teaching deaf students.*

- Is there is an association between teachers using e-learning in their teaching and the number of topics taught by the teachers? Hypothesis: *there are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning by teachers due to the number of topics they teach.*
- Is there is an association between mathematics teachers using e-learning in their teaching and the number of topics they teach? Hypothesis: *there are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning by mathematics teachers due to the number of topics they teach.*
- Is there is an association between teachers using e-learning in their teaching and the number of PCs available in the school? Hypothesis: *there are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning due to the number of PCs in the school.*
- Is there is an association between teachers using e-learning in their teaching and the tools that are available for teaching? Hypothesis: *there are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning due to the availability of tools.*

5.3. PILOT STUDY

The pilot study on the questionnaire was used to evaluate its reliability, credibility, clarity and the time required for its administration. It was conducted on 30 teachers working in two of the MOE' schools for special needs and disabled people, in the Al-Balaqa and Al-Karak districts. For more details on how the pilot was conducted, please see the previous chapter. The comments and feedback obtained revealed the following:

1. The guidelines on the questionnaire were clear and easy to follow.
2. Some of the abbreviations and terms were not clear enough for some of the teachers.
3. The average time needed to respond to the questionnaire was between 20-30 minutes, three of the thirty respondents felt that the questionnaire was a bit long.

Based on these comments, the questionnaire was reviewed and revised. Those terms and abbreviations that were unclear were modified to avoid any misinterpretations. Based on this, a redesigned questionnaire was produced and implemented, with the following aspects:

- The questionnaire was written in modern standard Arabic.
- The time taken to fill out the questionnaire not to exceed thirty minutes.
- An official letter in Arabic was sent to the schools and the teachers, explaining the research project and its aims. The main purpose of these letters was to ask the schools and teachers to participate, while at the same time assuring the participants of their privacy and confidentiality (see appendix E).
- As stated in the last chapter, the questionnaire was completed in the presence of the researcher within participating schools.
- The headmasters of the schools were deliberately involved in arranging the implementation of the questionnaire in order to demonstrate the importance of the study to the teachers.
- Although the researcher went through all the questions with the participants before they started to fill in the questionnaire (clarifying, explaining and giving examples of each item in the questionnaire), participants were invited to ask the researcher further questions at any stage.
- Teachers were informed in the initial letter that they had the right not to take part in the study, not to respond to any part of the questionnaire they did not feel comfortable with, or to withdraw at any time (ethical issues).
- The original questionnaire was translated from English to Arabic and reviewed by a professional linguistic translator. After the translation, the questionnaire was translated back into English by a different translator in order to assess whether the meaning had been maintained. This step was applied to the other questionnaire as well.

5.4. INSTRUMENTS & RESULTS

5.4.1. Questionnaire

The questionnaire was distributed to all teachers in the five schools. It consisted of the following data-collecting items: years of teaching (experience), academic qualifications, and subjects taught (other than mathematics, if any). Further questions asked about the teachers' experience in using ICT and e-learning systems; how often they used e-learning per semester; how they rated the current e-learning material; and whether they felt it was suited to the needs of the deaf pupils.

The completed questionnaires provided valuable statistical data about the participating schools and an overview of the current situation.

As mentioned in the last chapter, the questionnaire in a hard copy format was prepared and distributed by hand and completed in the presence of the researcher so that he could clarify any questions for the participants. The data were collected in October 2009 and treated using the SPSS statistical package.

5.4.1.1. Outcomes and Discussion

In the participating schools, 65 teachers responded to the questionnaire. The results showed poor use of ICT tools and e-learning due to a lack of ICT skills and a lack of availability of e-learning systems. Moreover, the teachers were found not to be well prepared for teaching the deaf as they had generally come from regular schools or from other areas of special education, such as education for the visually impaired, or physical, mental, and multiple handicaps. Additionally, most of the teachers lacked any knowledge of communication methods, such as Jordanian sign language (JSL or LIU) or any other means of communicating when they started working with the deaf. In this section, a summary of the data gathered in the questionnaire is provided.

5.4.1.2. Personal Background, Years of Experience of Teaching Deaf Pupils and the Number of Subjects taught

The aim of this section of the questionnaire was to gain a clear idea about the teachers, their experience and skills in relation to teaching deaf pupils and the subjects they teach. The study revealed that the responding teachers had an average age of 35.369 years with a minimum of 26 and a maximum of 48.

Table 5. 1: Study Sample Distribution based on Age, Gender, Teaching Mathematics, Years of Teaching the Deaf and Number of Topics Taught

		Frequency	Percentage
Age	26-31 years	27	41.5
	32-37 years	11	16.9
	38-42 years	15	23.1
	43-48 years	12	18.5
Gender	Male	7	10.8
	Female	58	89.2
Teach Mathematics	Yes	15	23.1
	No	50	76.9
Years of experience teaching deaf students	1-3 Years	10	15.4
	4-6 Years	7	10.8
	7-9 Years	18	27.7
	More than 9 years	30	46.2
Number of topics taught by teachers	One Topic	23	35.4
	Two Topics	11	16.9
	Three Topics	9	13.8
	Four Topics	16	24.6
	More than Four Topics	6	9.2
	Total	65	100

The main reason for determining the years of experience of the teachers is to test later for a link between this and their experience of using ICT and e-learning tools and employing such skills in their teaching. It will be important to determine whether they have been able to use such skills in their teaching throughout their careers and, if not, why not. For now, however, we simply show the years of experience of teaching deaf pupils.

Table 5.1 above showed that 15% of the respondents had 1-3 years of experience of teaching deaf pupils, 11% had 4-6 years, 28% had 7-9 years and 46% more than 9 years. This is illustrated in Figure 5.1.

The following table breaks down the distribution in more detail.

Table 5. 2: Study Sample Distribution Based on Gender, Age and Teaching of Mathematics

Age Range	Teaches Mathematics			Teaches other topics			Total		
26 - 31 years	Male	Female	Total	Male	Female	Total	Math	Other	Total
	1	4	5	4	18	22	5	22	27
	20%	80%	100%	18.18%	81.81%	100%	18.51%	81.49%	100%
	50%	31%	33%	80%	40%	44%	33%	44%	42%
32 - 37 years	Male	Female	Total	Male	Female	Total	Math	Other	Total
	0	4	4	0	7	7	4	7	11
	0%	100%	100%	0%	100%	100%	36.36%	63.64%	100%
	0%	31%	27%	0%	16%	14%	27%	14%	17%
38 - 42 years	Male	Female	Total	Male	Female	Total	Math	Other	Total
	1	3	4	1	10	11	4	11	15
	25%	75%	100%	9.09%	90.91%	100%	26.26%	73.34%	100%
	50%	23%	27%	20%	22%	22%	29%	22%	23%
43 - 48 years	Male	Female	Total	Male	Female	Total	Math	Other	Total
	0	2	2	0	10	10	2	10	12
	0%	100%	100%	0%	100%	100%	16.67%	83.33%	100%
	0%	15%	13%	0%	22%	20%	13%	20%	18%
Total	Male	Female	Total	Male	Female	Total	Math	Other	Total
	2	13	15	5	45	50	15	50	65
	13%	87%	100%	10%	90%	100%	23.1%	76.9%	100%
	100%	100%	100%	100%	100%	100%	100%	100%	100%

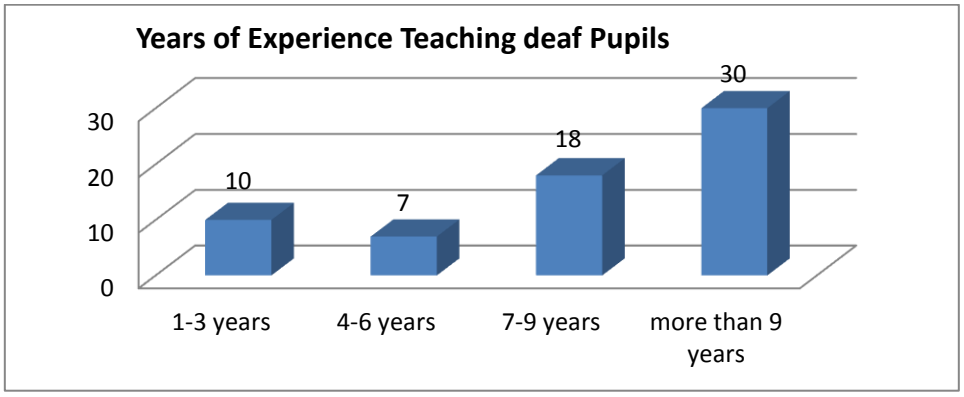
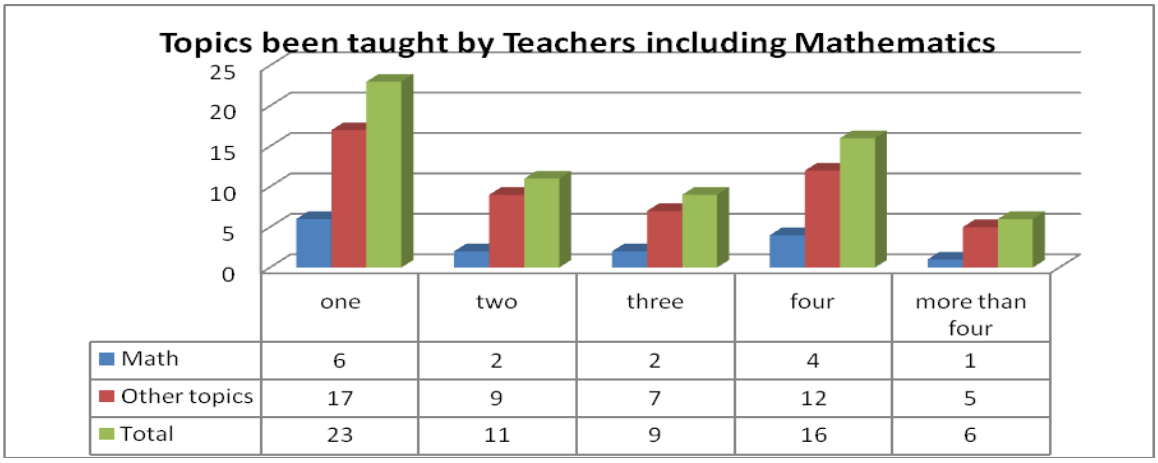


Figure 5. 1: Teachers' years of experience and their numbers

Teachers who teach one topic make up 35% of the sample; 17% teach two topics, 14% teach three, 25% four and 9% more than four.

Teachers who only teach mathematics represent 26% of all of the teachers who teach only one subject. Teachers who teach mathematics and one other subject represent 18% of all teachers who teach two subjects. Teachers who teach mathematics and two other subjects represent 22% of all teachers teaching three subjects. Teachers who teach mathematics and three other subjects represent 25% of all teachers teaching four subjects. Teachers who teach mathematics and more than four other subjects represent 17% of all teachers teaching at least five subjects. The exact numbers of teachers in each category are shown in the figure below.



	one	two	three	four	more than four
Math	6	2	2	4	1
Other topics	17	9	7	12	5
Total	23	11	9	16	6

Figure 5. 2: Subjects being taught by Teachers including Mathematics

The following table shows the distribution in terms of years of experience and number of topics taught.

Table 5. 3: Study Sample Distribution Based on Number of Topics Taught, Whether Teaching Mathematics and Years of experience

Topics/ years of experience	1-3 years			4-6 years			7-9 years			More than 9 years			Total		
	Math	Other	Total	Math	Other	Total	Math	Other	Total	Math	Other	Total	Total Math	Total Other	Total
One topic	2	4	6	0	3	3	3	7	10	1	3	4	6	17	23
	33%	67%	100%	0%	100%	100%	30%	70%	100%	25%	75%	100%	26%	74%	100%
	100%	50%	33%	0%	40%	44%	43%	64%	42%	17%	12%	13%	40%	34%	13%
Two topics	0	2	2	0	0	0	0	0	0	2	7	9	2	9	11
	0%	100%	100%	0%	0%	0%	0%	0%	0%	22%	78%	100%	18%	82%	100%
	0%	25%	27%	0%	0%	0%	0%	0%	0%	33%	29%	30%	13%	18%	13%
Three topics	0	2	2	0	0	0	2	2	4	0	3	3	2	7	9
	0%	100%	100%	0%	0%	0%	50%	50%	100%	0%	100%	100%	22%	78%	100%
	0%	25%	27%	0%	0%	0%	29%	18%	23%	0%	13%	10%	13%	14%	13%
Four topics	0	0	0	0	2	2	1	1	2	3	9	12	4	12	16
	0%	0%	0%	0%	100%	100%	50%	50%	100%	25%	75%	100%	25%	75%	100%
	0%	0%	0%	0%	22%	20%	14%	9%	18%	50%	38%	40%	27%	24%	13%
More than four topics	0	0	0	0	2	2	1	1	2	0	2	2	1	5	6
	0%	0%	0%	0%	100%	100%	50%	50%	100%	0%	100%	100%	17%	83%	100%
	0%	0%	0%	0%	100%	100%	14%	9%	100%	0%	8%	7%	7%	10%	13%
Total	2	8	10	0	7	7	7	11	18	6	24	30	15	50	65
	20%	80%	100%	0%	100%	100%	39%	61%	100%	20%	80%	100%	23%	77%	100%
	100%	100%	100%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

5.4.1.3. The Teachers' Competences and ICT Skills and how they employ these in their Teaching, and the Availability and Accessibility of ICT Tools, Infrastructure, LMS and E-Learning Platforms.

In this part of the questionnaire, the teachers were asked answer questions regarding the use and availability of some items mentioned in table 5.4. Table 5.4 illustrates that the item "conventional teaching tools (wooden crafted shapes, pens or other physical objects)" ranked first with a mean of 3.74 and a standard deviation of 1.136. This indicates that such tools are widely used in teaching the deaf in Jordan. Meanwhile, "online collaborative tools (forums, blogs and chatting software)" ranked last with a mean of 1.11 and a standard deviation of 0.312. This indicates that such online methods of communication are the tools that are used the least to teach deaf pupils in Jordan.

Table 5. 4: Descriptive statistic for availability of tools

Item	Mean	Std. Deviation	Percentage
Conventional Teaching Tools (wooden crafted shapes, pens or other physical objects)	3.74	1.136	74.80
Illustrations	2.58	0.934	51.60
Books (outside of the curriculum)	2.40	0.965	48.00
Educational TV and Broadcasting (Live)	2.06	0.950	41.20
Animations	1.71	0.805	34.20
Other Files (such as PDFs, Docs)	1.63	0.486	32.60
Recorded Video	1.63	0.741	32.60
CDs and DVDs	1.54	0.502	30.80
Web pages (HTML pages)	1.35	0.648	27.00
Presentations and PowerPoint Slides	1.26	0.443	25.20
Software Packages (Open Source or Commercial)	1.18	0.391	23.60
Online Collaborative Tools (forums, blogs and chatting software)	1.11	0.312	22.20
Total	1.85	0.693	36.98

In the third part of the questionnaire, the researcher investigated the teachers' competence and ICT skills, including the Internet, office products such as word processing, PowerPoint slides, and Excel spread sheets, e-mail and chatting software (such as MSN and Yahoo Messenger) and their use of computers as teaching tools. Respondents were asked about their ability at using the Internet for basic tasks such as accessing specific websites, using search engines and downloading/uploading materials such as documents in word or PDF formats.

The results showed that 9.2% of the respondents were able to use the Internet without any difficulties, 13.8% had little difficulty, 40% some difficulty, 23.1% reported finding the Internet difficult to use and 13.8% were unable to use the Internet at all. Moreover, regarding the ability to use productivity packages, such as Microsoft Office (Word, PowerPoint and Excel), 24.6% indicated that they were able to use such packages without any difficulty, 21.5% with little difficulty, 41.5% with some difficulty and 12.3% reported finding it very difficult to use productivity packages.

In this part, teachers were also asked whether they used e-mail and chatting software such as MSN and Yahoo Messenger. The kinds of questions used were dichotomous Yes/No questions. 55.4% responded "Yes" and 44.6% "No" when asked whether they use any computer/ICT tools in teaching, including e-mail, chatting, the Internet, or any other office productivity packages. 3.1% stated that they always used such tools in their teaching, 6.2% said they used them often, 7.7% occasionally, 15.4% rarely and 67.7% never used such tools in their teaching activities.

It was also found that 66.7% of the teachers who did not teach mathematics reported being able to use the Internet. Meanwhile, 53.3% of mathematics teachers reported having difficulties using the Internet.

In this part, teachers were also asked how many computers were used in teaching activities. 55.4% of the respondents indicated that between seven and nine computers were available for teaching in their school, 35.4% indicated a figure of 10-12 computers and 9.2% said that there were between four and six computers available for teaching at their school. However, according to the teachers, these computers are available only for the teaching of computer skills or other topics related to computers. Moreover, regarding the use of these computers by deaf pupils, 46.2% of those teachers indicated that computers were used by only one deaf pupil per class, 33.8% by two pupils at the same time per class and 20% by three pupils at the same time per class. Furthermore, 66.2% of the teachers stated that they never conducted their classes in the computer lab and never for teaching deaf pupils while 33.8% conducted their classes in the computer lab on a weekly basis or more often. This indicates that, although the schools have computers, they are currently little used for teaching purposes. Table 5.5, next page, provides more details:

Table 5. 5: Teachers' competence in ICT and employing it in teaching

		Frequency	Percentage
The ability to use the productivity packages and operating system	Very difficult to use	8	12.3
	Able to use with some difficulties	27	41.5
	Able to use with little difficulty	14	21.5
	Able to use without any difficulty	16	24.6
The ability to use the Internet (such as downloading and uploading files, searching and browsing)	Unable to use	9	13.8
	Very difficult to use	15	23.1
	Able to use with some difficulty	26	40
	Able to use with little difficulty	9	13.8
	Able to use without any difficulty	6	9.2
Do you have e-mail?	Yes	36	55.4
	No	29	44.6
	Total	65	100
Number of PCs available and used in your school	Four to Six PCs	6	9.2
	Seven to Nine PCs	36	55.4
	Ten to Twelve PCs	23	35.4
Number of users per PC in computer labs	One User/PC	30	46.2
	Two Users/PC	22	33.8
	Three Users/PC	13	20
How often do the deaf pupils have access to the computers inside the school?	Never use it	43	66.2
	On a weekly basis or more often	22	33.8
Do you think computers and the Internet are necessary for teaching deaf students?	Yes	54	83.1
	No	11	16.9
How frequently do you use computers and the Internet (e-learning) in your teaching?	Always	2	3.1
	Often	4	6.2
	Occasionally	5	7.7
	Rarely	10	15.4
	Never	44	67.7
The reasons behind not using e-learning and LMS in the schools	Lack of Confidence	2	3.1
	Lack of Specialised Software	42	64.6
	Lack of Hardware	6	9.2
	Lack of Training	11	16.9
	Educational Policies	4	6.2
Have you ever used any LMS or does your organisation use it?	Yes	10	15.4
	I don't know what LMS is	23	35.4
	No	32	49.2
Do you think that the current teaching tools are sufficient?	Yes	7	10.8
	No	58	89.2
	Total	65	100

5.4.1.4. Testing the Hypotheses

Hypothesis 1

There are no statistical differences (at $\alpha \leq 0.05$) between teachers' use of ICT skills due to their years of experience in teaching deaf students.

To test this hypothesis, one-way ANOVA (Analysis of Variance) was used; the following table shows the results:

Table 5. 6: Descriptive statistics for use of ICT skills by years of experience of teaching deaf students

Years of experience	N	Mean	Std. Deviation
1-3	10	3.40	0.876
4-6	7	4.14	0.802
7-9	18	3.00	0.840
More than 9	30	3.03	0.850
Total	65	3.20	0.901

Table 5. 7: One-way ANOVA results to test Hypothesis 1

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	8.176	3	2.725	3.802	0.014
Within Groups	43.724	61	0.717		
Total	51.9	64			

From the above table it is noticeable that the sig. value is less than 0.05, and hence we can conclude that there are statistical differences at $\alpha \leq 0.05$ in the use of ICT due to the years of experience of teaching deaf students.

To determine which group uses ICT the most, the researcher performed Scheffe post-hoc test of post comparisons, resulting in the following table:

Table 5. 8: Scheffe test

(I) Years of experience teaching deaf students	(J) Years of experience teaching deaf students	Mean Difference (I-J)
4-6	7-9	1.14286*
4-6	More than 9	1.10952*

Table 5.8 shows that there are significant differences between the means of the group with 4-6 years' experience of teaching deaf students and both the 7-9 years and more than 9 years groups. The difference was in favour of the 4-6 years of experience teaching deaf pupils. This means that there is an association between teachers' ICT skills and their years of experience of teaching deaf pupils. As illustrated in Table 5.8, the results show that the group of teachers who have taught the deaf for 4-6 years have better ICT skills the most. This is mainly because of the training programs conducted by the MOE and new university preparation programmes which focus on promoting ICT skills.

Hypothesis 2

There are no statistical differences (at $\alpha \leq 0.05$) in teachers' use of ICT skills due to their years of experience of teaching mathematics to deaf pupils.

To test this hypothesis, again, one-way ANOVA was used. The results are shown in the following table:

Table 5. 9: Descriptive statistics for teachers' use of ICT skills by years of experience of teaching mathematics to deaf pupils

	N	Mean	Std. Deviation
1-3	2	3.00	0.707
7-9	7	2.57	0.732
More than 9	6	2.83	1.169
Total	15	2.73	0.884

Table 5. 10: One-way ANOVA results for Hypothesis 2

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	0.386	2	0.193	0.219	0.806
Within Groups	10.548	12	0.879		
Total	10.933	14			

From the above table we note that the sig. value is more than 0.05, so we can conclude that there are no statistical differences at $\alpha \leq 0.05$ in the use of ICT skills due to years of experience of teaching mathematics to deaf students.

Hypothesis 3

T*here are no statistical differences at α ≤ 0.05 in teachers' use of ICT skills due to the number of topics they teach.*

Table 5. 11: Descriptive statistics for teachers' use of ICT skills by number of topics taught

Number of topics taught by teachers	N	Mean	Std. Deviation
One	23	3.26	0.838
Two	11	3.00	0.671
Three	9	3.22	1.176
Four	16	3.16	0.978
More than Four	6	3.42	1.068
Total	65	3.20	0.901

Table 5. 12: One-way ANOVA results for Hypothesis 3

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.842	4	0.21	0.247	0.91
Within Groups	51.058	60	0.851		
Total	51.9	64			

In the above table, sig. is more than 0.05, so we can conclude that there are no statistical differences at $\alpha \leq 0.05$ in the use of ICT skills in teaching due to the number of topics taught by the teachers.

Hypothesis 4

T*here are no statistical differences at α ≤ 0.05 in mathematics teachers' use of ICT skills due to the number of topics they teach.*

Table 5. 13: Descriptive statistics for mathematics teachers' use of ICT skills by number of topics taught

Number of topics taught	N	Mean	Std. Deviation
One	6	2.75	0.880
Two	2	3.75	1.061
Three	2	2.00	0.707
Four	4	2.63	0.854
More than Four	1	2.50	.
Total	15	2.73	0.884

Table 5. 14: One-way ANOVA for Hypothesis 4

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.246	4	0.811	1.056	0.427
Within Groups	7.688	10	0.769		
Total	10.933	14			

From the above, sig. is more than 0.05, so we can conclude that there are no statistical differences at $\alpha \leq 0.05$ in mathematics teachers' use of ICT skills due to the number of topics they teach.

Hypothesis 5

There are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning due to the number of years of experience of teaching deaf students.

Table 5. 15: Descriptive statistics for using e-learning by number of years of experience of teaching deaf students

Number of years of experience of teaching deaf students	N	Mean	Std. Deviation
1-3	10	4.20	1.135
4-6	7	4.43	1.134
7-9	18	4.39	1.037
More than 9	30	4.43	1.104
Total	65	4.38	1.071

Table 5. 16: One-way ANOVA results for Hypothesis 5

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.426	3	0.142	0.119	0.949
Within Groups	72.959	61	1.196		
Total	73.385	64			

In the above table, the sig. value is more than 0.05, so we can conclude that there are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning due to the number of years of experience of teaching deaf students.

Hypothesis 6

There are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning by mathematics teachers due to the number of years of experience of teaching deaf students.

Table 5. 17: Descriptive statistics for the use of e-learning by number of years of experience of teaching deaf students (teachers of mathematics)

Number of years of experience of teaching deaf students	N	Mean	Std. Deviation
1-3	2	4.50	0.707
7-9	7	4.57	0.535
More than 9	6	5.00	0.000
Total	15	4.73	0.458

Table 5. 18: One-way ANOVA results for Hypothesis 6

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.719	2	0.36	1.948	0.185
Within Groups	2.214	12	0.185		
Total	2.933	14			

In the above table the sig. value is more than 0.05, so we can conclude that there are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning by mathematics teachers due to the number of years of experience of teaching deaf students.

Hypothesis 7

There are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning by teachers due to the number of topics they teach.

Table 5. 19: Descriptive statistics for the use of e-learning by number of topics taught

Number of topics taught	N	Mean	Std. Deviation
One	23	4.13	1.14
Two	11	4.45	1.214
Three	9	4.33	1.323
Four	16	4.69	0.602
More than Four	6	4.5	1.225
Total	65	4.38	1.071

Table 5. 20: One-way ANOVA results for Hypothesis 7

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.111	4	0.778	0.664	0.619
Within Groups	70.273	60	1.171		
Total	73.385	64			

From the above table, we note that sig. is more than 0.05, so we can conclude that there are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning by teachers due to the number of topics they teach.

Hypothesis 8:

There are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning by mathematics teachers due to the number of topics they teach.

Table 5. 21: Descriptive statistics for the use of e-learning by mathematics teachers categorised by the number of topics they teach

Number of topics taught	N	Mean	Std. Deviation
One	6	4.67	0.516
Two	2	5	0
Three	2	4.5	0.707
Four	4	4.75	0.5
More than Four	1	5	0
Total	15	4.73	0.458

Table 5. 22: One-way ANOVA results for Hypothesis 8

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.35	4	0.087	0.339	0.846
Within Groups	2.583	10	0.258		
Total	2.933	14			

Sig. is more than 0.05, thus we conclude that there are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning by mathematics teachers due to the number of topics they teach.

Hypothesis 9

There are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning due to the number of PCs in the school.

Table 5. 23: Descriptive statistics frequency of use of e-learning categorised by for the number of PCs in schools

Use of e-learning	N	Mean	Std. Deviation
Always	2	1.67	0.471
Often	4	2.08	0.500
Occasionally	5	2.13	0.506
Rarely	10	2.33	0.567
Never	44	2.25	0.407
Total	65	2.23	0.449

Table 5. 24: One-way ANOVA results for Hypothesis 9

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.891	4	0.223	1.111	0.36
Within Groups	12.022	60	0.2		
Total	12.913	64			

From the above table, we note that sig. is more than 0.05, and thus conclude that there are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning due to the number of PCs in the schools.

Hypothesis 10

There are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning due to the availability of tools.

Table 5. 25: Descriptive statistics for the use of available tools due to e-learning use

Use of available tools in teaching	N	Mean	Std. Deviation
Always	2	1.58	0.354
Often	4	1.75	0.245
Occasionally	5	1.92	0.382
Rarely	10	1.90	0.380
Never	44	1.85	0.328
Total	65	1.85	0.332

Table 5. 26: One-way ANOVA for Hypothesis 10

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.23	4	0.057	0.505	0.733
Within Groups	6.829	60	0.114		
Total	7.058	64			

In the above table, sig. is more than 0.05, thus we conclude that there are no statistical differences at $\alpha \leq 0.05$ in the use of e-learning due to the availability of tools.

5.4.2. Interviews

Semi-structured interviews were conducted with teachers of mathematics to deaf pupils in the participating schools. These were aimed at facilitating the researcher's understanding of the teachers' perspectives of the problems they faced in the classroom when teaching mathematics. The researcher also hoped to gain a deep insight into the current major problems facing deaf pupils when learning mathematics within the Jordanian context.

All of the interviews were conversational in style, which allowed the teachers to express their own personal views on effective mathematics teaching and which tools and facilities in their opinion might help to improve deaf pupils' academic achievements in mathematics. Moreover, all interviews were carried out in public places or rooms with windows, such as teachers' rooms or headmasters' offices. The interviewees all completed and signed a consent form.

The researcher conducted fifteen formal semi-structured interviews with teachers of mathematics and many other informal interviews with other teachers, including an interview with the Head of the Salt Training and Resource Institute for Disability, Etc. (STRIDE).

5.4.2.1. Piloting the Interviews

Before conducting interviews with the teachers, the researcher piloted them with two teachers from special needs schools, with the main aim of testing their feasibility. The schools used for the pilot were MOE schools for special needs and disabled people in the Al-Karak district in Jordan. An approval letter was first acquired from the MOE. The significance and importance of this study and its potential impact on the education of deaf pupils in Jordan was discussed with the headmasters of the schools in order to seek their approval for conducting interviews in their schools. During the pilot interviews, the researcher explained the purpose of the research and the pilot study, and encouraged the teachers to criticise the interview and give suggestions for any improvements that could be made to the structure of the questions or the way it was administered. Enough time was given to each of the participants in terms of responding to the questions.

The feedback and notes of the teachers were taken into consideration. The comments and feedback obtained revealed the following:

1. The questions language and structure were clear and easy to follow.
2. Some of the ellipses were not clear enough.
3. The average time needed to respond to the questions was between 15 and 20 minutes.

5.4.2.2. Interview Responses and Discussion

This section will present the results obtained from the semi-structured interviews conducted with teachers of mathematics to deaf students. The results will be summarised into three categories:

1) The main problems facing the deaf when learning mathematics;

2) The main topics in mathematics that deaf children have problems with; and

3) The sort of electronic modules, such as chatting, PowerPoint presentations, interactive materials, external resources and video-conferencing, that could be used within the e-learning environment.

The results of each interview question are given in the following sections:

Q1. What is your method of teaching mathematics to the deaf?

- Teachers answered that they were in favour of using traditional, conventional teaching methods (lecturing), such as using the blackboard, following textbook examples and demonstrating how to answer questions on the blackboard.
- The teachers reported that they could not fully adapt to the needs of all deaf students in their classes and deliver equal information and teaching to all of them at the same time. Moreover, some of the teachers expressed concerns that they could not keep the students' attention.
- The researcher was informed that using external resources or any other methods were felt to be time-consuming and to require extra preparation which would add to the workload for teachers who also taught other subjects. Therefore, using any other methods or external resources was felt to be incompatible with a heavy teaching load.

Discussion

Based on the above, the teachers use basic teaching methods within the regular classroom. This method of teaching will deactivate the students' role in the classroom, which will delay the learning process (Merchant, 2007). Moreover, the method promotes one-way communication, which makes the student the receptor and the teacher as the transmitter. This is in line with what the teachers informed the

researcher about being unable to know whether the students had grasped the information provided to them. This indicates that there is no proper communication between the teachers and their deaf pupils.

Another issue worth mentioning is that while attending some mathematics classes the researcher observed that deaf pupils were separated into classes containing only deaf pupils of the same age range. This is a big problem when the class has only two to three students, as it will limit communication and interaction among them and with the teachers (deaf pupils should learn to communicate with others, both younger and older than themselves).

Another observation is that most of the teachers of the deaf are not fully qualified to teach deaf pupils. Their qualifications are not related to teaching the deaf. Most of their competence comes from experience rather than training. The teachers are not well-prepared to teach the deaf in particular, as they come from regular schools or a wide variety of special education categories, such as education for the visually impaired, and physical, mental, and multiple handicaps. Additionally, most of the teachers lacked any knowledge of Jordanian sign language (JSL or LIU) when they started working with the deaf.

Q2. What are the topics you think it is hard for deaf children to learn in mathematics?

From the teachers' responses, the main problems occur in the following topics:

- Number

Deaf pupils were noted to have some mathematical problems regarding the concept of numbers, numbering order and the concept of comparing numbers using 'less than', 'greater than' and 'equal to'. They also had problems counting numbers with different digits in an ascending or descending order, negative numbers, whole numbers, place values, number names and number patterns.

One of the common problems mentioned by the teachers is that students often cannot differentiate between numbers containing the same digits, such as 42 and 24,

35 and 53… etc. this problem accrued due to the language of teaching. This come from the fact that the text books are written in formal Arabic and the explanation comes in the form informal Arabic or sign language which teachers are not competent in.

- Operations of numbers, such as addition, subtraction, multiplication, division and fractions

Deaf pupils were stated to have some mathematical problems with adding numbers greater than 10, adding more than four numbers, and problems with using different words to express addition, such as 'altogether'. They also had problems with number patterns in addition.

When deaf pupils were asked to perform subtraction they often failed to distinguish between taking away and the difference between. Similarly to addition, deaf pupils had some mathematical problems when dealing with base 10 numbers, as zero posed difficulties. Moreover, deaf pupils have some problems even in subtracting smaller numbers with bigger ones such as (3-7) and number patterns in subtraction.

When performing a multiplication of a single digit by a number with multiple digits, deaf pupils often get confused about which number to start with. Moreover, some of the teachers said that some deaf pupils face problems when multiplying by a multiple of ten, such as 20, 30 or 40. Deaf pupils face problems when learning about fractions considered as part of a whole or when dealing with equivalent fractions Teachers indicated that deaf pupils were unable to establish a link between words and symbols, such as ⅔ versus two-thirds. They also often fail to recognise the equivalence of the decimal and fraction forms.

According to Moss & Case (1999), the learning of fractions is an area of mathematics that children find particularly challenging and in the case of deaf pupils it is even more difficult. Additionally, students can experience difficulties in learning fractions due to rushing to a symbolisation before a strong conceptual understanding of numbers and operations has been established (Reys et al., 2001; Pearn & Stephens, 2004).

Discussion

Analysing the answers given to this question, it can deduced that the main problem appears to be to do with the deaf pupils' counting abilities and particularly their ability to recall numbers in the right sequence. According to Nunes (2004), deaf people find it much more difficult to recall items in a particular sequence than hearing people do. Moreover, Nunes & Moreno (1998) indicate that there is no direct link between deafness and mathematical difficulties. They argue that not all deaf people are weaker mathematically than hearing people and that there is no evidence of a link between mathematics and deafness. They explained instead that the problems that face most deaf pupils are due to a lack of access to adequate sources of information, which minimises their incidental learning, as a consequence of their lack of hearing (Nunes & Moreno, 2002).

Therefore, based on the above, it can be concluded that the reason for deaf pupils' lack of competence in mathematics compared to that of hearing pupils is more likely to be due to the fact that they have missed out on the basic foundations of mathematics, namely counting and recalling numbers in the right sequence. Moreover, this indicates that classroom and parental communication.

Q3. Why do you think it is hard for deaf children to learn these topics in mathematics?

The teachers gave two reasons in response to this question. The first reason, according to them, is the language used to deliver mathematics. This includes the language of mathematics itself, the Arabic language in which all the learning materials are presented in the textbooks and the communication method used in the classroom (sign language or lip-reading).

The other reason, according to the teachers, is the acknowledged lack of resources available for them to deliver the learning materials in different ways and change their patterns of teaching. This, according to the teachers, hinders their progress as they are bounded by the constraints of traditional teaching methods.

Discussion

The responses indicate that the teachers need to spend more time preparing their lessons to compensate for the difficulties in communication and the lack of resources available for the deaf pupils; this means that they need to rehearse their lessons more and thus require more time.

Moreover, in order for teachers to produce more resources to overcome the problem of teaching deaf pupils, they will require more time and their teaching load will increase. They are not currently being paid for this additional commitment.

The lack of communication between the teachers and the deaf pupils contribute to delay in learning as more time is needed to comprehend the language and then the topic been taught which is in line with the findings of Foisack (2005). Foisack (2005) indicates that hearing pupils take less time when learning mathematics than deaf pupils. This indicates the importance of providing deaf pupils with a bilingual education within the Jordanian context.

Q4. How do you clarify difficult topics and concepts in mathematics?

The researcher received two types of responses to this question. One portion of the teachers said that they tend to skip some mathematical topics and concepts if they feel that the deaf pupils are having a hard time grasping them. Others said that they still went through the topics but placed less attention on them. One teacher informed the researcher that:

"*Although I covered the curriculum textbook, knowing that my students were having some problems with specific concepts, I tended during the examination time to skip difficult topics and concepts in the examination and did not include them in my examinations*".

Discussion

The teachers' responses to this question showed that they tended to skip some mathematical topics and concepts if their pupils found them confusing. Other

teachers, who did cover these topics, did not pay a great deal of attention to them and ignored them when assessing the deaf pupils.

According to Shulman (1986), Content Knowledge (CK) is the teacher's knowledge of the topics they are teaching and Pedagogical Knowledge (PK) refers to how they use their CK with different methods, practices and techniques in their teaching. The combination of the two terms is referred to as Pedagogical Content Knowledge (PCK).

Skipping part of the content because of the problems they might face in teaching it to the deaf pupils shows that the teachers have a lack PK, despite having very good CK (most of the teachers interviewed held bachelor degrees in mathematics and science). This problem with PK will inevitably lead to a problem with PCK. However, Wong & Lai (2006) emphasise the importance of PCK and described it as a "*crucial factor leads to effective mathematics teaching*".

Q5. Does the use of lip-reading and sign language enable you to present and explain mathematics in a clear way?

The short answer to this question was "yes", as the teachers felt it enabled them to communicate more effectively with the deaf pupils. All of the teachers responded to this question with a positive answer such as, "Yes", "Sure", "Absolutely" or "Of course this will help". However, eleven out of the fifteen teachers interviewed expressed concerns about teachers' proficiency in sign language and lip-reading.

One of the interesting insights the researcher gained was that none of the teachers had a BA in Deafness Studies or a BA in Classroom Mathematics, nor had they attended any classes in sign language either during their degree or after graduation.

Discussion

The explanation for this lack of ability in deaf communication lies in the fact that there is a lack of university programmes in deaf studies. In 2003, a Department of Hearing and Speech Sciences was established at the University of Jordan in Amman. At that time, the department was one of the first university departments in

Jordan and the surrounding region to offer academic degrees in hearing and speech sciences. Moreover, when the researcher looked at the requirements for the Bachelor's degree in Special Education, among 130 credits only three credits were allocated to providing an introduction to hearing impairment. Therefore, it can be concluded that this lack of university preparation of graduates has forced the MOE in Jordan to hire teachers who are not capable of dealing with and teaching deaf pupils within the classroom environment.

Although the MOE hired these teachers, they failed to support them with proper training in sign language or any other training related to teaching deaf pupils.

Q6. Do you have any software (E-learning and LMS's) or have you developed any presentations to help you to teach mathematics at the elementary level?

The simple answer to this question was "No". Moreover, teachers expressed their disappointment in the clear lack of such applications and software dedicated to deaf education in Jordan. One of the teachers expressed his disappointment by saying that "*the ministry of education has invested in so-called discovery schools, but has failed to include a single school for the deaf in this project*".

It is important to note that the *discovery schools project* is aiming to implement e-learning into mainstream schools and the MOE has chosen 100 schools for the project. All of the schools participating in the project are located in Amman and none of the deaf schools are participating.

The teachers said that they very rarely obtained external resources and did not have time to develop their own, other than occasional PowerPoint slides. They sometimes also obtained material from student teachers studying for degrees in special needs education.

Discussion

All schools participating in the Jordan Education Initiative (JEI) are fully connected to an online curriculum, covering 3,200 teachers and 80,000 students and none are deaf. Moreover, this project has delivered 3,373 e-learning lessons in different

subjects including Arabic language, mathematics, science and others (Jordan Education Initiative, 2005).

The MOE has put a huge amount of effort into reforming its educational policy by implementing these e-learning lessons and attempting to utilise ICT in the educational system through the JEI (Jordan Education Initiative, 2005). However, the decision-makers at the MOE have failed to include schools for the deaf in this initiative. This means that teachers of the deaf in schools for the deaf are unable to access the available resources and proves that the MOE has given less attention to educating deaf students than their hearing counterparts.

Another finding from this question was that student teachers developed presentation slides only for the purpose of showing their university tutors that they were doing their homework. However, these slides lack sufficient quality and quantity in terms of covering the required topics in maths and other subjects and the student teachers appear to have used only the conventional teaching methods (the slides are not interactive, do not provide feedback and do not provide any sort of interaction between the deaf pupils and their teachers). The student teachers appear to have been constrained by their relatively low level of ICT skills when developing these learning materials and this also applies to the teachers themselves.

Q7. Do you find that varying the methods used to deliver learning materials helps children to learn mathematics?

The teachers expressed their support for varying delivery methods when teaching deaf pupils so as not to rely solely on the textbook. Moreover, teachers expressed concern that the textbook was the only source provided to the deaf for learning mathematics, stating that it would limit both the deaf pupils' and the teachers' options during school time, and force a specific method of teaching and a specific learning style on them. The teachers informed the researcher that the deaf pupils, however, are visual learners and rely on their visual sensory as their main input. Using visual learning materials when teaching deaf pupils would therefore help them and help the deaf pupils to learn.

Another point about which the teachers raised their concerns was deaf pupils' studying outside of school. In this matter, teachers admitted to being unsure about how much learning deaf pupils were able to do without help at home. They also felt unable to determine whether their teaching was working and whether it actually suited the deaf pupils.

Discussion

With the textbook being the only resource available for learning mathematics and with the lack of communication tools available, teachers are unaware of whether deaf pupils find it easy or difficult to understand their teaching. This type of feedback is important so that the teacher can focus on the topics that are causing difficulties. The problem of communication with the deaf pupils makes this situation even worse. Moreover, the daily 45 minute mathematics class is not enough for the deaf pupils. The teachers do not know about the deaf pupils' situation at home. However, it is certain that deaf pupils are likely to be isolated from their colleagues and teachers and unable to gain help and clarification of certain ideas when they are at home. This indicates that deaf pupils are having accessibility and collaboration issues. Therefore, using different methods of delivery at different times would give more options to the deaf pupils to learn at their own pace and in their preferred style.

As it well known that visual perception is the main sense which deaf pupils rely on to process learning materials (Wang, 2006). Therefore, using different methods to deliver learning materials, with an emphasis on visual effects, is essential for enriching the learning experience. However, there also needs to be a guarantee that any learning materials presented in a visual way are presented accurately.

Q8. What sort of features should an e-learning system provide to you and your deaf pupils?

Teachers responded that they needed some sort of mechanism to track their deaf pupils' actions to make sure that they were accessing the e-learning system in the right way and using the right learning materials at the right time. Moreover, the

teachers informed the researcher that they needed to be able to monitor how the deaf pupils were progressing in their studies.

Another important point emphasised by the teachers was that any e-learning system introduced should have support for the Arabic language. Also, some of the teachers expressed a desire to exchange learning materials and resources with teachers in other schools in order to enhance their teaching methods.

The teachers also felt that any e-learning system to be used by their deaf pupils should emphasise the use of different types of communication, such as chat, forums, messages (e-mail) and video streaming.

Discussion

Analysing teachers' responses to this question, it can be deduced that teachers currently lack the ability to track their students' progress in mathematics and possibly other topics, in the traditional classroom. The ability to track the deaf pupils would allow the teachers to judge their progress across several topics (for example, which topics are being studied more than others and by which pupils and any topics that are being ignored by the deaf pupils). This implies that teachers currently lack certain administrative tools. According to Rego, Moreira, & Gracia (2007), the administrative aspect is one of the key technical features of e-learning systems.

The teachers emphasise that the e-learning system interface should be in Arabic or support Arabic. This is because Arabic is the teachers' first language and likely to be the first or second language for their deaf pupils. This is, according to Rego, Moreira, & Gracia (2007), another of the technical aspects of e-learning systems and categorise it under adaptation and personalisation.

The teachers also informed the researcher, in an indirect way, of their desire to exchange learning materials with other teachers. This implies that they should be able to import learning materials (learning objects, LOs) into the system. In an e-learning system, this is known as resource management. Resource management includes LO management, LO search, LO upload and download and LO sharing and

reusing. In the e-learning field, this is called interoperability and is considered to be a dependability aspect of an e-learning system (Al-Dahoud, Walkowiak, & Woda, 2008).

Finally, the teachers emphasised the use of communication tools. Such tools are an essential part of any e-learning system. In this context, they will help to increase the amount of communication and collaboration that goes on among the deaf pupils and between them and hearing people.

5.5. Summary

The main problem facing deaf pupils when learning mathematics in Jordan is often their lack of ability to count, which is a result of the fact that deaf people find it very hard to recall items in a particular sequence in comparison to hearing people. This problem is exacerbated by a variety of other reasons:

5.5.1. Teaching Method

The teachers use the basic (conventional) method of teaching, which takes place inside a regular classroom. Using this method, it is not possible for the teacher to give one-on-one attention to deaf pupils. It also deactivates the role of the deaf pupil, making his/her participation in the classroom passive instead of active. Moreover, in any class, the students will have different learning styles, some deaf pupils will learn better by visual means, while others may prefer doing (the hands-on approach); the teacher alone cannot accommodate all of these learning styles. Therefore, in any learning environment, there should an emphasis on presenting learning materials using the appropriate means that suits the learning style of the learner since it will enrich their learning experience.

5.5.2. Teacher's qualifications

Most of the interviewed teachers, all of whom are teaching the deaf in Jordan, are not fully qualified to teach deaf pupils. Their qualifications are not related to teaching the deaf and in some cases they are not even related to the subjects they are teaching. In addition, there is a clear lack of training and support from the MOE as

well as a lack of training programs and qualifications offered by the universities in Jordan and the region as a whole.

Teachers of the deaf in Jordan often have qualifications related to teaching wider aspects of special education, including education for the visually impaired, and for people with physical, mental, and multiple handicaps. This indicates that those teachers lack CK. Meanwhile, another segment of the teachers hold degrees in the topics they are teaching, such as a BSc in Mathematics, etc. Although these teachers have CK, they lack PK. Most of these teachers' competence in teaching the deaf has come from practical experience. Therefore, with one group having problems with CK and the other with PK, ultimately, all of the teachers lack sufficient PCK.

Experience is the main factor that the teachers rely on when teaching deaf pupils and they use this to overcome their deficiencies in communication skills.

5.5.3. Lack of Communication

There is a lack of communication (competency in sign language, lip-reading and total communication) stemming from the fact that none of the teachers had a BA in Deaf and Deafness Studies or a BA in Classroom Mathematics Teaching or had attended any classes in sign language or any other means of communication either during their degree course or after graduation. The outcome of this lack is that deaf pupils will need more time to grasp concepts than hearing learners will.

5.5.4. Lack of Resources (textbook)

One of the main reasons why deaf pupils face problems when learning mathematics is the lack of internal and external resources. Although the MOE has put a huge amount of effort into reforming its educational policy by implementing 3,373 e-learning lessons in different topics and trying to utilise ICT in the educational system through the JEI, unfortunately, none of these lessons are accessible to the deaf pupils or their teachers.

Although small efforts have been made by student teachers during their time in schools, these efforts lack sufficient quality and quantity in covering mathematical topics and use conventional teaching methods (i.e., they are not interactive, do not

provide feedback and do not produce any interaction between the deaf pupils and their teachers); it seems that the student teachers have been constrained by their ICT skills in this regard. The lack of such resources puts a greater time requirement on the teachers since more rehearsing and repetition is required when they are constrained to the textbook. Moreover, 67.69% of teacher reported that they never make use of available tools in their teaching.

2.3.5. Access to the support of teachers and colleagues and learning materials

The limited time spent on mathematics of only 45 minutes a day creates a lack of access (using only the textbook) to learning materials and teacher support. Moreover, when the deaf pupils are at home, they are isolated from the teachers, their colleagues and any other tools that do exist in the school. It is unlikely that they will be able to get clarification of mathematical ideas while at home. Another part of this problem is a lack of easy collaboration for the deaf pupils outside of school.

5.5.5. Teachers recommendations and requests for e-learning system features

The teachers gave a number of key responses to the question about what sort of facilities they require from an e-learning system. These were based on different situations. The teachers expressed a need for the ability to track the progress of the deaf pupils, for them and their students to be able to use the system at any time and for it to serve their demands and needs (both teachers and pupils). According to Al-Dahoud, Walkowiak, & Woda (2008), this is known as the dependablity aspect of e-learning systems (availability and stability). The teachers also strongly requested an Arabic interface to the e-learning system, as this would make it easier to use (this is known as usability).

They also requested support for collaboration among the users, through a set of communications tools such as video-conferencing, live chatting, messages (e-mails), forums and notes. Finally, in an indirect way, the teachers expressed a desire to use other resources built by others. This is called interoperability and is

considered to be one of the dependability aspects of an e-learning system (Al-Dahoud, Walkowiak, & Woda, 2008).

5.5.6. The development of end user criteria for the LMS and the e-learning system

- The LMS and e-learning system should be accessible at anytime and anywhere, through the use of the Internet.
- The system should not replace the teacher, but should act as a complementary and supplementary system to enrich his/her teaching, provide more space and more tools, more learning resources and overcome the one-size-fits-all dilemma.
- The system should provide the ability to import external learning resources (web sites and other files, such as PowerPoint slides and video material).
- The system should support different collaborative tools, to ensure better communication and the ability to share resources.
- This is summed to the problems are already mentioned above and needs to be solved through the use of an LMS/LCMS such as lack resources, lack support, lack accessibility, lack communication and lack of training.
- The system should provide the feedback feature; the feedback should be delivered to the deaf pupils in two types. The first type is the feedback from the teachers and the second is from the content itself.
- The system should provide the users with Interactive Content (IC), this include providing immediate feedback to the deaf pupils when solving a problem or/and explaining the steps of solving specific mathematical problems.
- Interactive content for multiple choice questions showing the feedback associated with the right and wrong answers

CHAPTER 6

EVALUATION OF FOUR OPEN SOURCE LMS

6.1. INTRODUCTION

In this chapter, the comments and suggestions of the teachers of the deaf regarding their needs from an e-learning system are considered; with the aim of determining the feasibility of using currently available open source LMS's. There are two main reasons behind using open source LMS. Firstly, this research is not funded by any governmental or non-governmental institutions and the use of open source LMS is free of charge and does not require a license. Secondly, open source LMS have huge support from their communities which will provide help, assistance and guidance during period of research.

In this chapter, the main focus is to choose a LMS and e-learning system that satisfies the main requirements for teaching the deaf in Jordan (for both the instructors and the deaf students) and does not raise resistance to using such systems.

The researcher evaluated four open source LMS and recommends one of them as the most adaptable for deaf children in Jordan. The evaluation consisted of testing the LMS against the key requirements developed based on the literature, the comments and suggestions of the interviewed teachers of the deaf in Jordan, and the guidelines of the California Department of Education, which contain suggestions used in classifying, assessing, planning, and providing appropriate educational services to all children who are deaf or hard of hearing (The State Special Schools Division, 2000). Additionally, the researcher used some of the suggestions from the LMS Evaluation Tool User Guide, Issue 1.2 (3waynet Inc. & The Commonwealth of Learning, 2004).

During the evaluation, the researcher noted the main factors that affect the use of e-learning system and LMS. These include language support, hardware/software specifications, Relational Database Management System (RDBMS), LMS standards and specifications compliance, administrative tools, assessment tools, collaboration and communications tools, and the customisation of the LMS. After completing the

evaluation, it was found that the most suitable open source e-learning environment and LMS for the deaf children's needs was "Moodle" LMS. Therefore, this was adopted for the deaf children in Jordan.

6.2. METHODOLOGY

The internet was used as the main data collection method in this research. Evaluating and comparing LMS is not new in the field of e-learning. Several studies have been conducted comparing LMS, including the work of Graf and List (2005). Qualitative weight and sum approach in their comparison of nine LMS was used. Moreover, they emphasise the adaptability issue in their comparison. Botturi (2004) bases his comparison of open source LMS on the criterion of assessment functionality. García and Jorge (2006) base their evaluation and comparison on SCORM inter-operability and conforms between LMSs. Meanwhile, others such as Itmazi and Megias (2006) and Kljun, Vicic, Kavsek, & Kavcic (2007) base their comparisons on more than one criteria. According to Emmanouilidis, Papathanassiou, & Papakonstantinou (2008), evaluation and comparison studies of LMS are subjective in their results due to the different criteria used and the tendency to focus on a single criterion or set of criteria. They also state that each evaluation is affected by the time and context in which the LMS were tested. For example, new features are being introduced to LMS all the time and later evaluations of LMS including such features will award more points. Therefore, any evaluation of a specific LMS can only consider its status at the specific time the evaluation was conducted.

According to Emmanouilidis et al. (2008), there are two types of user to be considered in a LMS evaluation. The first is the end user of the system who is concerned with the features and tools the system offers to enhance and support their learning. The other type is the developer, who is concerned about how to adapt and modify, encompass, extend and install, promote and elevate, and import and export learning materials from one LMS to another. In their study, Itmazi and Megias (2006) surveyed 58 studies of LMS comparisons and evaluations. However, none of the these studies targeted specific end users such as deaf users, except for the work of Khwaldeh and Shah (2010).

According to Emmanouilidis et al. (2008), the main aspect that developers consider when evaluating LMS are accessibility, reusability, interoperability, durability, adaptability and affordability. However, users mainly focus on the usability of the system and the features that the LMS presents which can be used by them.

In any web-based system, including LMS, one of the main issues raised is accessibility. Any LMS is likely to provide some features which could cause accessibility problems both for users in general and more particularly for users with disabilities. According to CANnect (2010), such accessibility issues can be avoided if they are addressed during the design stage. One example of an accessibility issue occurs when using the chat feature for real-time synchronous discussion. Some users find it very hard to follow the discussion if there is a mechanism to distinguish between the users' contribution to the chat panel, because of the fast flow. Another problem could occur in identifying the speaker. Another accessibility issue that could occur is keeping track of progress with lessons and learning materials (bookmarks).

The inter-operability of LMS is the ability of the LMS to integrate with related external applications and systems, such as plugins for applications and websites, and support for main learning objects standards such as SCORM, AICC, IEEE and IMS (Emmanouilidis et al., 2008).

Reusability is the ability of the LMS to use and accept learning objects from different LMS. This feature allows a wide range of learning objects to be imported and reused from other LMS and influences the cost of developing learning objects.

Adaptability refers to whether an LMS can be adapted and modified to the needs of the end users (Emmanouilidis et al., 2008).

From the end users point of view, LMS should be a user-friendly platform with visual enhancements, and integrated tools and services, such as authoring and assessment tools. CENT (2004) defines usability as efficiency combined with simplicity and ease of use. Al-Dahoud et al. (2008) emphasise the importance of the usability aspect of an LMS, as it serves the use and access, distribution and demonstration of the learning objects and materials.

In this evaluation, the researcher used the QWS approach proposed by Baumgartner, Häfele, & Maier-Häfele (2002). This approach assesses the strengths and limitations of the evaluted LMS. It has previously been used by Graf & List (2005). Graf & List base their methodology on the general usage requirements, such as the active community that supports the LMS, a constant development status for the LMS and the availability of LMS documentation. In the pre-evaluation stage in this research, eight LMS are evaluated.

In the second stage of evaluations, the researcher used some of the aspects of Kerkiri & Paleologou's (2009) evaluation methodology, including availability of / access to a variety of alternatively selectable resources, the ability to modify the LMS interface, the collaborative space, the ability to keep statistics and import/export learning content using learning standards. Some of the criteria of Kalochristianakis, Paraskevas, & Varvarigos (2008) were also used, namely, users' (teachers and students) suitability tools, technical specifications, administrative and management features and collaboration and communication tools. Finally, the researcher used the Edutools website (www.edutools.info) to validate the outcomes of the evaluation.

6.2.1. Open Source E-Learning Systems

The Open Source Initiative (OSI) (2010) defines open source as "*a development method for software that harnesses the power of distributed peer review and transparency of process. The promise of open source is better quality, higher reliability, more flexibility, lower cost, and an end to predatory vendor lock-in*". This has been used to determine if a software license is considered as open source. The definition was based on the Debian Free Software Guidelines (Debian, 1997). The philosophy behind this is to make the source code of such software available to others and to outline the terms of practice, any adjustment that can be made to it and any restructuring and distribution of the software. An example of this type of practice is the so-called general public license (GPL or GNU), which provides the license to use, modify and distribute the software in question.

The flexibility of open source LMS software is much greater than that of commercial LMS. This flexibility comes from the ability to customise open source LMS as such systems are not tied down by a license. Moreover, open source LMS provides flexibility

in terms of the usability of the system itself, by opening the learning content to a wider audience, while if this was required in a commercial LMS, a re-negotiation of the license would be required with the vendor.

Open source LMS can be adapted to an institution's educational style and can be used based on their educational philosophy. On the other hand, the vendors of commercial LMS cannot cover all the learning styles and demands of all customers. According to Stuart Lee, the Director of Computing Systems and Services at Oxford University, the use of open source LMS allows for flexibility to take place in the form of adjusting and reforming the open source to make it more applicable to the university style (Guo, 2010).

In this chapter, a specific features of the evaluated open source LMS are investigated, such as administrative tools, customisation, communication tools, and assessment tools. This will allow specifying the most suitable open source LMS for deaf pupils and their teachers in Jordan. The first step was to choose the four open source LMS to be evaluated.

6.2.2. The Choice of LMS/LCMS

According to Al-Dahoud et al. (2008) the core of any e-learning system is its platform. This "*should have to meet four essential functions as: student's management, dissemination of knowledge, testing progress of its absorption and communication between e-learning process actors (users)"*. The researcher used this along with the outcomes of the reviewed evaluations such as the one conducted by Botturi (2004) which is a comparison of seven open source LMS, CENT's (2004) comparison of three open source LMS, based on content creation and authoring, communication and teaching/learning activities and workgroup environments, and another project, conducted for the University of Valencia in Spain in which e-learning management systems were evaluated and compared by the Corporate University Enterprise (CUE, 2003), to choose the LMS to be evaluated in this study.

According to Tomas (2010), there are several things to be considered when deploying an LMS in an institution, including servers, operating system and Internet browsers. Therefore, it is essential to consider these in the evaluation. Another aspect to consider

when choosing a specific LMS is the community that supports it. This includes support from developers and user communities in developing new features and improving the current ones. This was behind Florida International University' (FIU) decision to transition from their commercial LMS to an open source one (FIU, 2010).

The four LMS that were chosen were Moodle, Sakai, OLAT and ILIAS. The choice was based on:

- Customisation requirements, such as personalisation and adaptation, multilingual support, including Arabic language support, software, hardware and custom development requirements; openness, including open source code, designed for easy modification and new, custom modules;
- Standards compliancy, such as adhering to specifications such as SCORM, IMS, and AICC, and importing and managing content and courseware that complies with the standards, regardless of the authoring system that produced it;
- Reliability and scalability, such as the suitability of the LMS for different sizes of installation and how easily they could accommodate an increasing number of users, or greater content or functionality;
- Hardware and software considerations, that is, supporting multiple operating system platforms, including open source operating systems such as Linux, client browser requirements and database requirements.

The following sections provide a brief description about each of the chosen LMS.

6.2.2.1. Moodle

Moodle, is an abbreviation, which stands for Modular Object-Oriented Dynamic Learning Environment. It is an open source LMS which is considered to be an e-learning software platform. Besides being a LMS, Moodle is also known as a Course Management System (CMC) and a Virtual Learning Environment (VLE) (Moodle.org, 2010; Cole & Foster, 2008).

According to statistics on its website, Moodle has 49,611 registered and validated websites across 212 countries and is used by 38,205,321 people across the globe. For further statistics, please visit the website (http://moodle.org/stats/). The Moodle

Graphical User Interface (GUI) has been translated into eighty languages (as at 2009), including English, German, Greek and Arabic (Moodle.org, 2010).

Martin Dougiamas was the developer and founder of Moodle LMS, which he developed during his PhD (Dougiamas & Taylor, 2003). It has a variety of features, such as forums, chat, blogs, quizzes, content management and, most importantly, multilingual support. Moodle is an independent platform, which means that the data is stored in a separate database, such as MySQL, Microsoft SQL or Oracle (Rasoolzadeh, 2008). Moreover, it is a copyright LMS under the GNU license meaning that it is an open source LMS that can be copied, used and modified. However, the price for this comes in the form of providing source code to others without changing the original license (Moodle.org, 2010; Dougiamas & Taylor, 2003). The researcher downloaded and installed Moodle in order to conduct an evaluation and comparison, for the purposes of this study. A copy of the latest version of Moodle (Moodle 2.0) can be downloaded at http://moodle.org/downloads/.

6.2.2.2. SAKAI

According to Emmanouilidis et al. (2008), Sakai is one of the most well-known LMS available in the market, and is supported by a large community of advocates. Sakai is an open source LMS and provides different features to users through a collaborative learning environment including workspace tools, generic collaboration tools, teaching tools and portfolio tools (Sakai.Org, 2010). Sakai is free software that is distributed under the educational community licence, which falls under the category of open source licenses. It is a Java-based application and runs on Java platforms, which are mainly developed by Sun Microsystems. Java is licensed under the general public license (GNU).

Recently, the Sakai project produced two products called Sakai CLE and Sakai OAE. Sakai CLE is a collaboration and learning environment which is used by millions of users in different educational institutions, such as schools, colleges and universities. Its main function is to enhance collaborative teaching, learning and research (Sakai.Org, 2010). The Sakai OAE project is an open academic environment that is currently under development. This project incorporates all the features of Sakai CLE with an emphasis on academic collaboration. It focuses on certain aspects such as the social activities of

the users and links them through social networking based on academic communities. The aim is to make this an even more personal experience (Sakai.Org, 2010).

SAKAI comprises a number of handy features, such as a calendar, forums, chat rooms, a live virtual classroom, blogs, discussion forums and messaging services (internal e-mails). Moreover, Sakai supports several learning standards such as SCORM, IMS and AICC, a content management system, an assignment system, statistics generation and much more (Sakai.Org, 2010). Moreover, more than 150 educational institutions have already adopted Sakai, with between 200 and 200,000 users each (Sakai.Org, 2010).

For this study, the researcher evaluated hosted online Sakai CLE at rSmartmySakai (https://mysakai.rsmart.com/xsl-portal), which requires the user to register at rSmartmySakai, in order to experience and explore the system. The following figures show the use and evaluation of the SAKAI features:

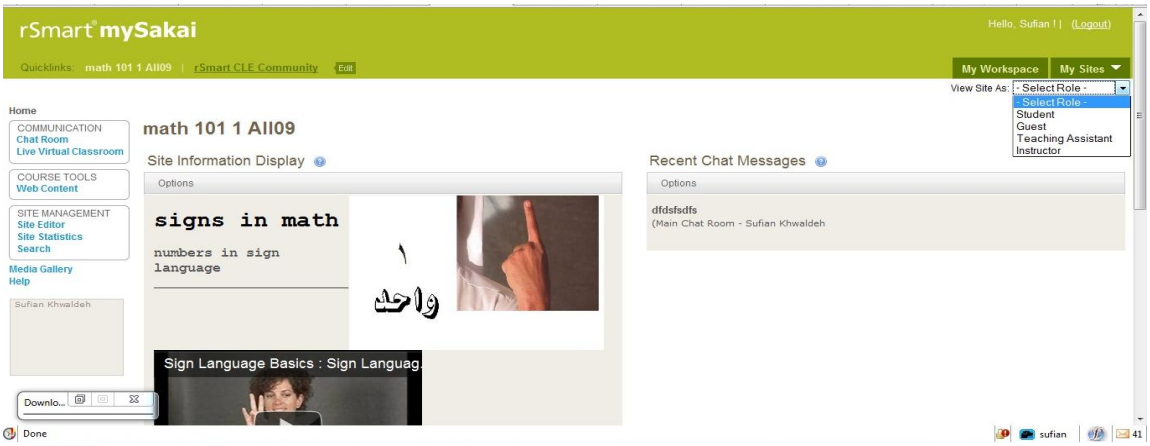


Figure 6. 1: Using Sakai

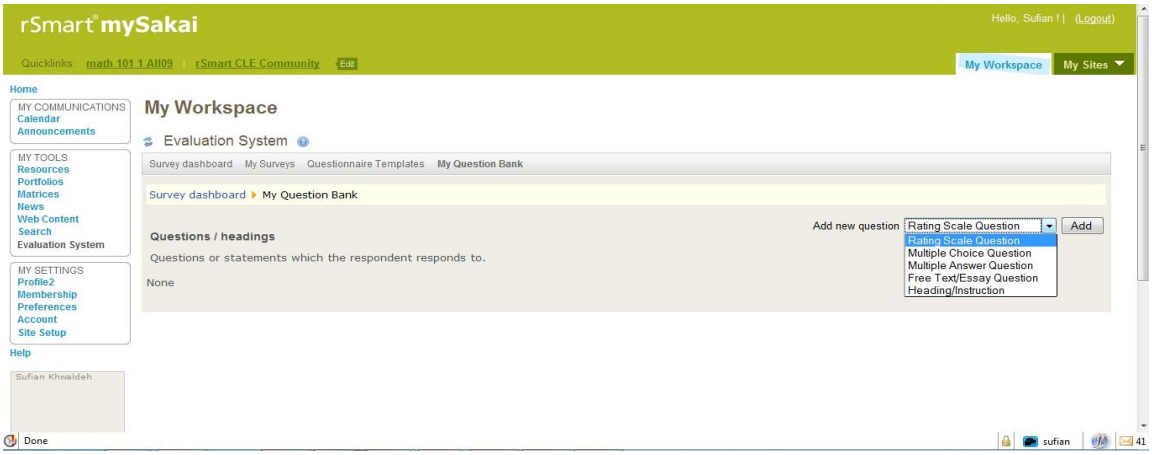


Figure 6. 2: Using Sakai, the evaluation system and types of questions Sakai supports

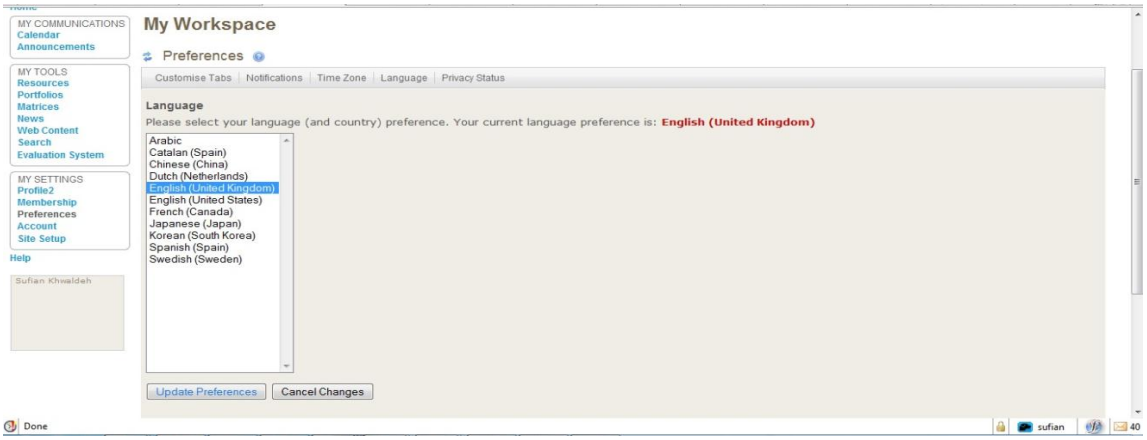


Figure 6. 3: Using Sakai, the preferences page and languages that Sakai supports

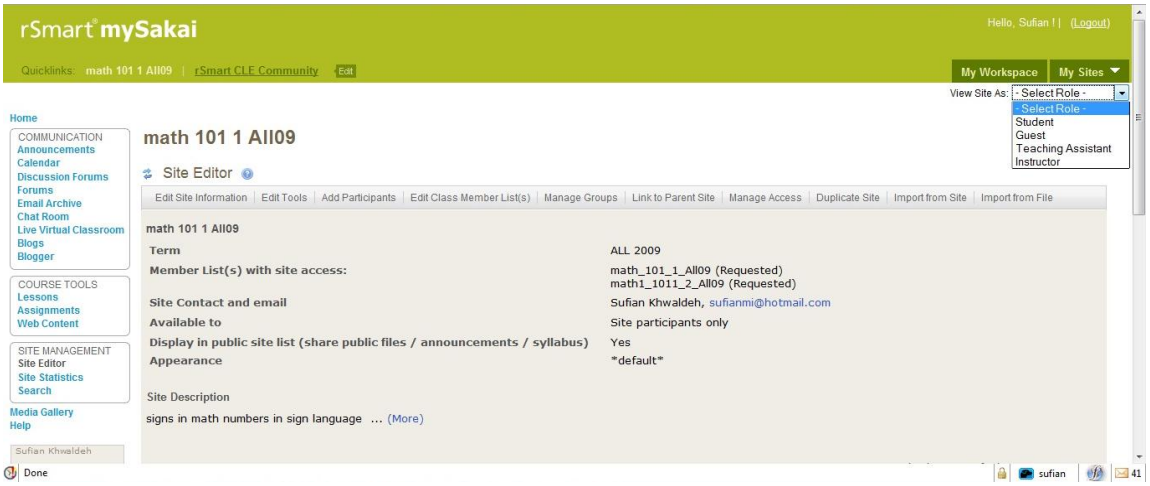


Figure 6. 4: Using Sakai, the evaluation of the administrative tools which are available for the user and the available roles that Sakai supports.

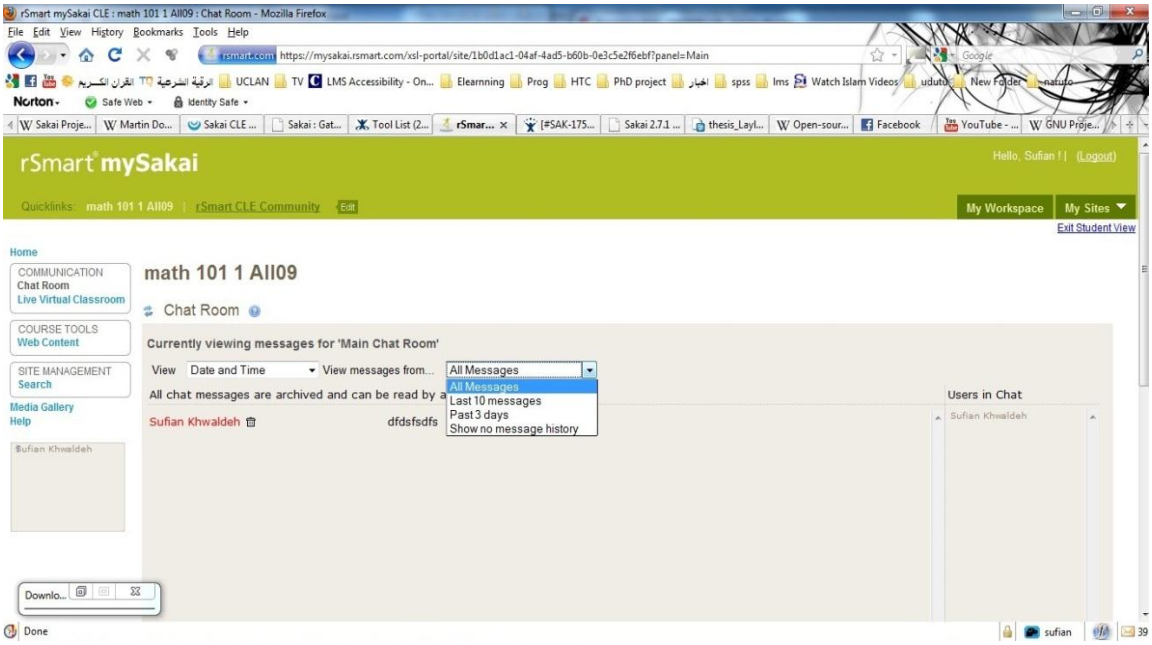


Figure 6. 5: Using Sakai, the evaluation of the chatting features in Sakai and its ability to show and view messages and options.

6.2.2.3. OLAT

OLAT, which is a web-based LMS, stands for Online Learning and Training. It is free software that is distributed under the Apache license, and authored by the Apache Software Foundation (ASF). It falls under the category of open source license and free software license, which is compatible with the GNU general public license, meaning that OLAT is free of charge (OLAT, 2010). OLAT system was developed by researchers at the University of Zurich, Switzerland. It has been used and deployed in over 32 countries, with 150 installations worldwide and is used by higher education institutions and universities (OLAT, 2010). However, it is worth mentioning here that no educational institutions in Arab states have deployed OLAT as yet.

OLAT's GUI has been translated to support 27 languages (as of 2009). This support varies depending on the language. For example, English and German are supported 100%, Greek 90%, and Arabic 21%. In 2010 a further languages were added and the level of support included, English and Italian 100%, Polish 92%, and Indonesian 4% (OLAT, 2010). Moreover, OLAT provides an online translation tool. According to OLAT's website the languages currently under development include Arabic, Hebrew and Hungarian (OLAT, 2010).

OLAT provides a plentiful array of manageable features, such as calendar for every course the user is enrolled in, and for groups of users, forums, chat rooms, instant messaging services (internal e-mails), wikis and blogs. Moreover, OLAT supports several learning standards including SCORM, IMS CP, IMS LTI and QTI. Regarding scalability, OLAT supports an unlimited number of users, with different roles including managerial roles, and permissions, such as modifying, adding and deleting accounts. It also provides a full text search tool for finding learning materials, course management tools, assessment tools and much more (OLAT, 2010).

For the evaluation, the researcher downloaded and installed OLAT, version 6.3.3. A copy of the latest version of OLAT can be downloaded from the website (http://www.olat.org/website/en/html/unit_download.html). However, the researcher experienced many problems starting OLAT. Therefore, it was necessary to use the version hosted at the organisation's website in order to carry out the evaluation and comparison. To access and use the hosted demo version of OLAT, please visit

(http://demo.olat.org/demo/dmz/). The following figures demonstrate the use and evaluation of the OLAT features:

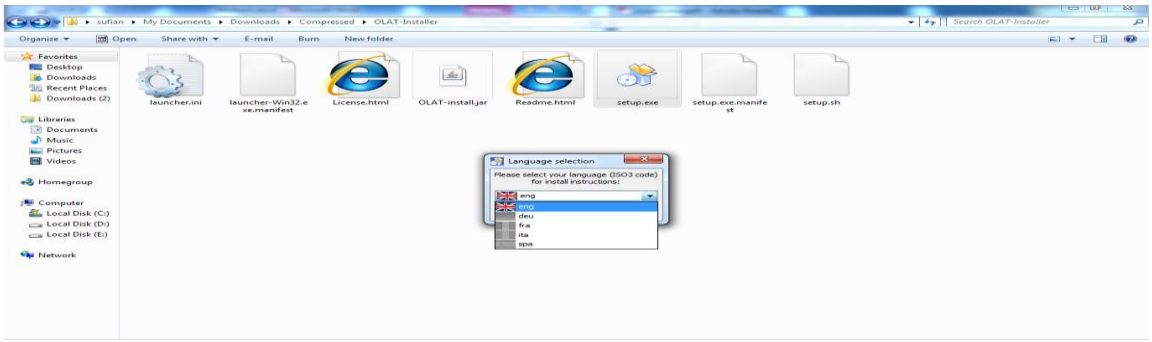


Figure 6. 6: Using OLAT: during the installation there were five languages to choose from.

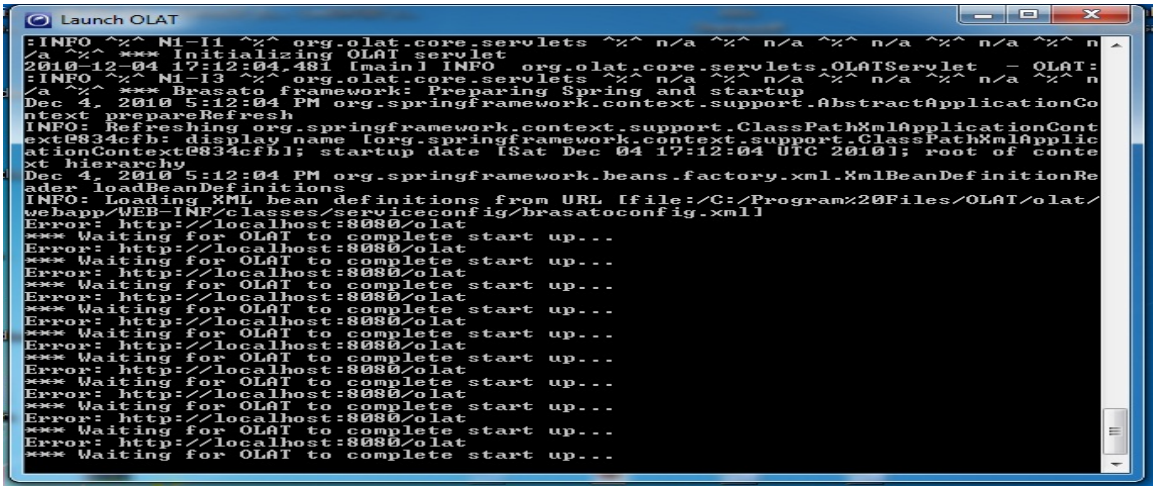


Figure 6. 7: Using OLAT: after installation, the researcher had a problem starting OLAT on his computer

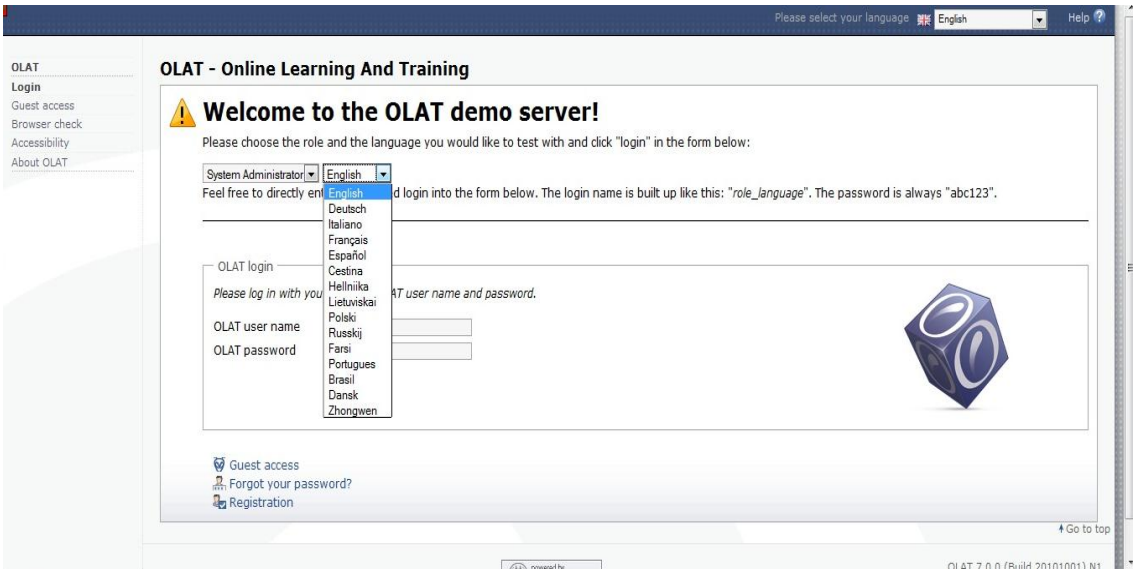


Figure 6. 8: Using OLAT: the login page provides fifteen choices of language

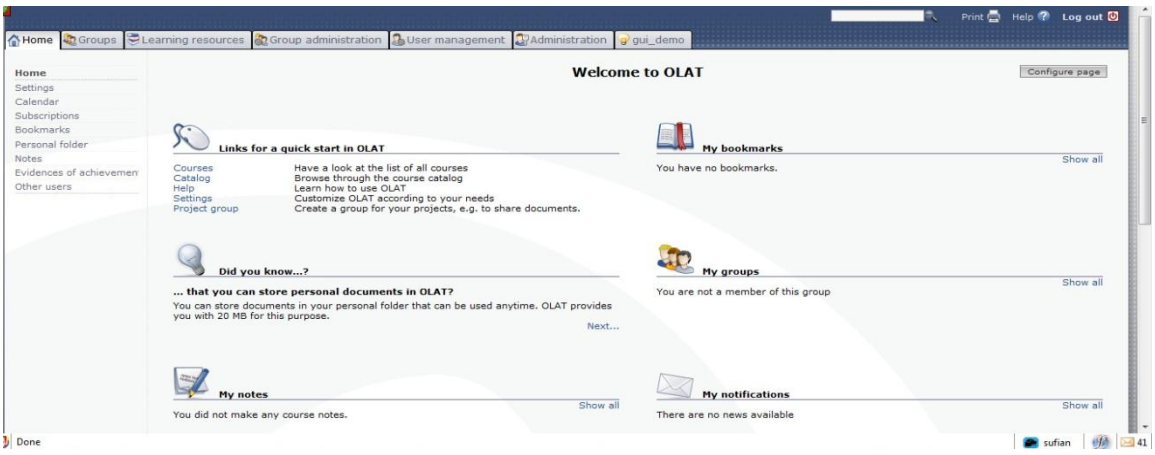


Figure 6. 9: Using OLAT: the main page after user login.

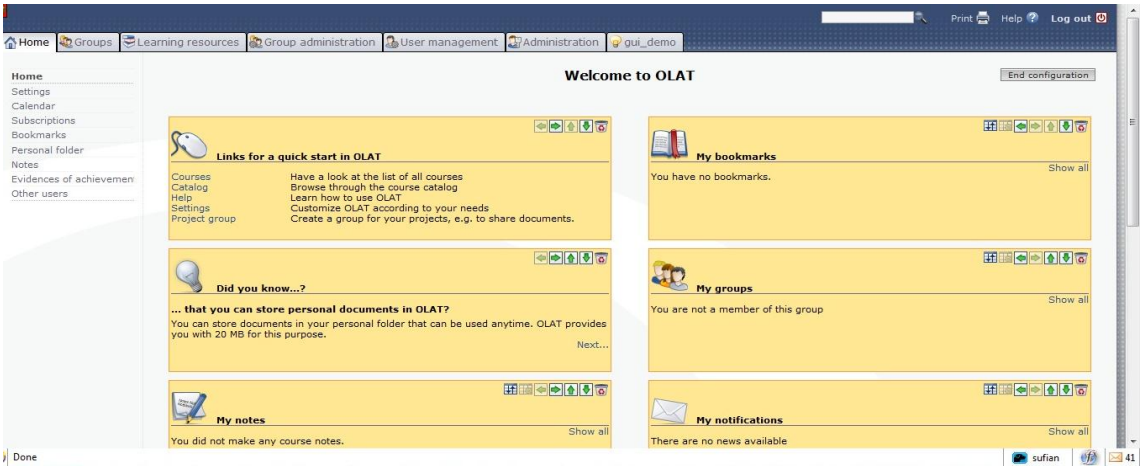


Figure 6. 10: Using OLAT: the customisation feature of the main page that gives the ability to add and remove tools and features as required

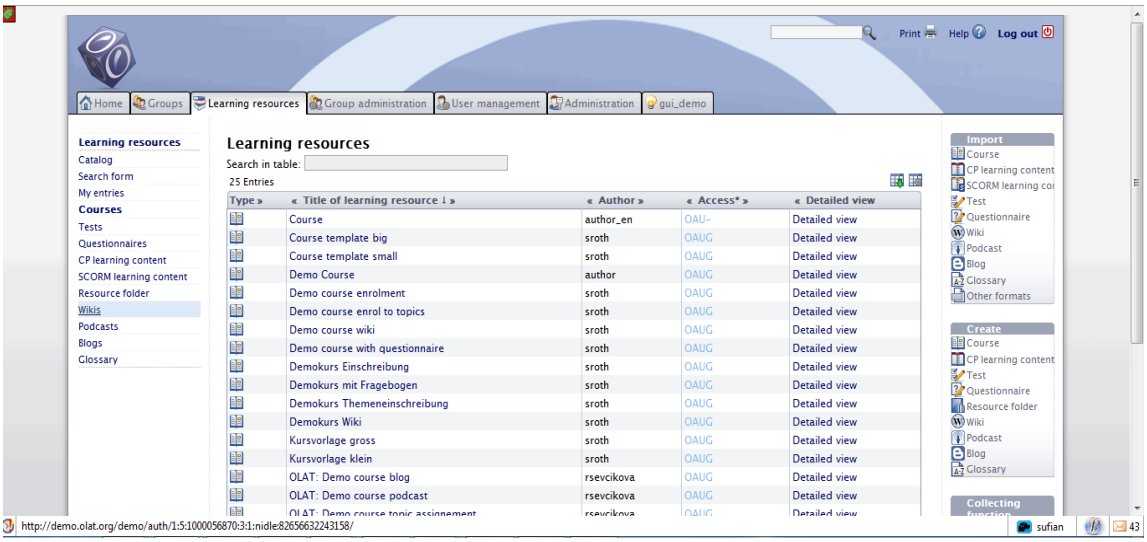


Figure 6. 11: Using OLAT: managing learning resources, such as importing and exporting learning materials, tests, questionnaires, blogs, glossaries, and SCORM learning content.

6.2.2.4. ILIAS

ILIAS is a web-based LMS project, started under the supervision of Professor Liedhold at the University of Cologne in Germany (Campus Source, 2010). In German, ILIAS stands for Integriertes Lern-, Informations- und Arbeitskooperations-System) which in English means Integrated Learning, Information and Work Cooperation System (Museum of Learning, 2010). ILIAS is provided to individuals and institutions free of charge as it is published and distributed under a General Public License (GNU) (ILIAS, 2010).

Campus Source (2010) describes ILIAS as a web-based LMS that provides flexibility in delivering learning content through several means and supporting numerous learning standards, such as AICC, SCORM 1.3, SCORM 1.2, LOM metadata, IMS QTI and many others. Such flexibility allows the management of the learning resources to be carried out in an effective way, which make ILIAS a potent web-based LMS (Campus Source, 2010). One of the main features of ILIAS is the ability it gives the user to author, create and distribute content. It also provides other features, such as managing the learning process of the learners, collective tools that create assessments and tests, communication and collaboration tools such as forums, chat, notes, messages (internal e-mail system), a group system, which promotes collaborative learning, effective administrative tools, such as assigning roles to users, and enabling the tools that can be used by each type of user, and user interface languages (ILIAS, 2010). According to Campus Source (2010), ILIAS is used in more than twenty countries on many different levels including school, university and business, and supports more than twenty languages.

One of the main features of ILIAS is the personal desktop (or main page) provided to the user, where he/she can access their sessions, carry out their latest activity in a specific session or participate in a live virtual working group. Moreover, ILIAS provides a repository system for the users so that they can use specific learning materials in different e-learning courses and group lessons together (ILIAS, 2010).

This personal desktop also provides the user with general information about his membership of courses and groups. On the block management which is a panel that

provides the user with a calendar, notes, bookmarks and contacts, which can be organised by mailing list, group, or courses. Moreover, it provides shortcuts to the user's personal profile, news, the repository, the search facility, internal mail and information about the last visit the user made to his/her courses.

For the evaluation, the researcher used the version of ILIAS that is hosted at the ILIAS website. To access the hosted demo version of ILIAS, please visit (http://www.ilias.de/docu/). The following figures demonstrate the use and evaluation of the features of ILIAS.

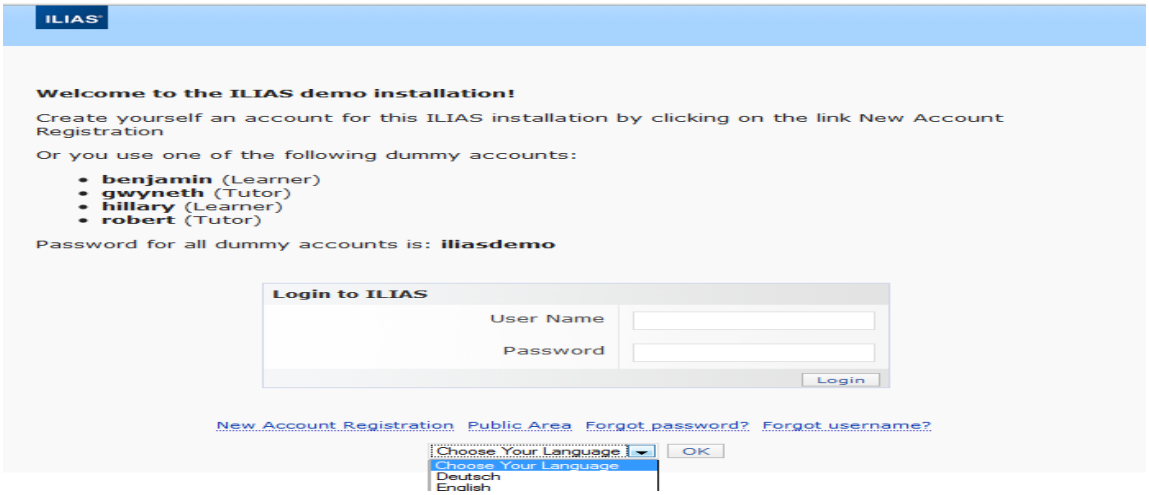


Figure 6. 12: when the researcher evaluated this demo version, there were only two languages available for the login screen

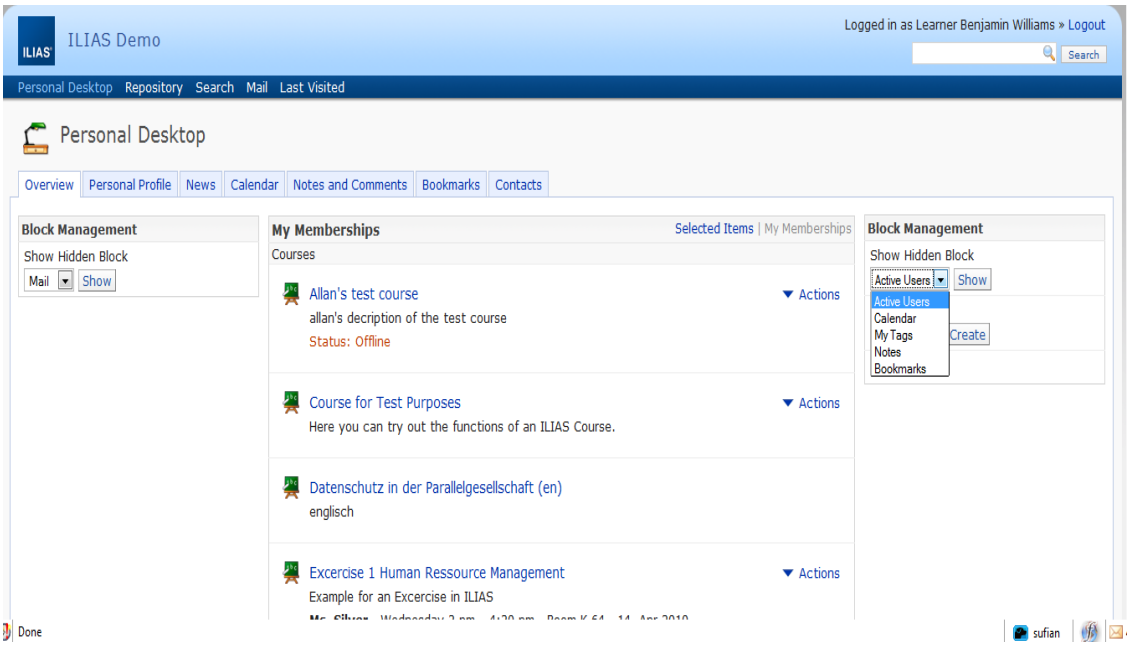


Figure 6. 13: Using ILIAS: the main page or personal desktop

6.3. EVALUATION AND RESULTS

In order to carry out the evaluation, a points system was used. This involved allocating points to each of the LMS based on how well it was able to support the key requirements in a variety of different aspects: software/hardware specifications, RDBMS, LMS standards and specifications compliance, administrative tools, collaboration and communication tools, customisability and assessment tools. The more aspects supported by the LMS, the more points allocated.

The following sections deal with each of the above aspects in turn. The key requirements for each aspect are shown in the tables. The letters "Y" and "N" stand for "YES" and "NO", respectively, indicates whether or not the evaluated LMS supports the requirement in question.

6.3.1. Evaluation of Hardware/Software Specifications

The table below illustrates the comparison between the four LMS from the hardware/software requirement perspective.

Table 6. 1: Hardware/Software Comparison between the Evaluated LMS

H/S Requirements	**ILIAS**	**Sakai**	**Moodle**	**OLAT**
Operating System Types	Cross-platform	Cross-platform	Cross-platform	Cross-platform
Server Type support	Cross-platform	Cross-platform	Cross-platform	Cross-platform
Points	2	2	2	2
Total Accumulated Points	2	2	2	2
Total Accumulated Percentage	100%	100%	100%	100%

This section of the evaluation looked at whether the LMS are able to run on the Microsoft Windows operating system, and on Linux. All of the evaluated LMS can be run on either Microsoft Windows or UNIX operating systems as they all use supported internet browsers, such as Internet Explorer, Firefox, Chrome and Safari. This meant that all of the LMS were given one point for satisfying the operating system requirement.

By making several field trips to schools in Jordan and observing the ICT infrastructure available, the researcher obtained a complete picture of the current structure regarding computers and the operating systems they were running, internet connection speeds, internal networks and other applications such as office productivity packages. Tomas (2010) recommends ensuring that all computers have an appropriate operating system, and to get the best performance from an LMS, that all computers should run the same operating system.

The main reason for considering server type support in this evaluation is that LMS depends on the servers as this has a direct link to the scalability of an e-learning system, that is, the number of users and the size of the database needed to store the learning materials. LMS require various different types of servers, including database servers and web services servers (Tomas, 2010).

From the table above it can be seen that all of the evaluated LMS are cross-platform, meaning that they can run over different server types. Therefore, each LMS received one point for this requirement as well.

6.3.2. Evaluation of Relational Database Management Systems (RDBMS)

The RDBMS types required to support LMS vary depending on the LMS itself. However, before discussing RDBMS, it is necessary to provide a brief introduction to the term SQL, which stands for Structured Query Language. SQL was developed by IBM in 1975 and is used by administrators to access, modify, update and delete information in a database. It is used in web database development and can be accessed through a script language such as PHP (Groff & Weinberg, 1999).

MySQL database is an open source Database Management System which provides users with access to a stored database (Schumacher & Lentz, 2007; MySQL Reference Manual, 2007). According to Schumacher & Lentz (2007), MySQL has been used by Google and Yahoo to deal with more than 1.5 billion queries a day and with more than 21 terabytes of database.

The Oracle database is a Database Management System that enables users to access a stored database in a database server; the oracle license is commercial or proprietary and

was developed by the Oracle Corporation 33 years ago. It runs on Microsoft Windows and Linux (HP, 2010).

Microsoft SQL Server is another RDBMS supported by the LMS's evaluated in this study. This RDBMS was founded and developed by Microsoft Corporation and is licensed under an end user license agreement. PostGreSQL is an Object-Relational Database Management System (ORDBMS), which is open source and licensed under its own license (PostgreSQL, 2010). The table below shows which of the LMS support each of the RDBMS.

Table 6. 2: RDBMS Support for Evaluated LMS

RDBMS	**ILIAS**	**Sakai**	**Moodle**	**OLAT**
MySQL	Y	Y	Y	Y
Oracle	N	Y	Y	Y
Microsoft SQL	N	N	Y	Y
PostGreSQL	N	N	Y	Y
Points	1	2	4	4
Total Accumulated Points	3	4	6	6
Total Accumulated Percentage	50%	67%	100%	100%

As we can see from Figure 6.14, the most preferred and commonly used RDBMS among the evaluated open source LMS is the MySQL with 100%, then Oracle with 75%, and finally Microsoft SQL server and PostGreSQL with 50% each.

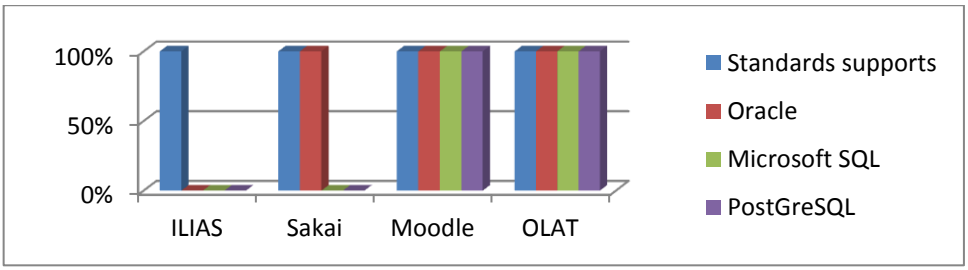


Figure 6. 14: Percentages of LMS supported by each RDBMS

As stated before, MySQL is a GNU General Public License (GNU or GPL), which is a widely used free software license. Being a GNU gives MySQL an advantage as it is free and as it is open source it can be modified as needed. Moodle and OLAT were the only two evaluated LMS that supported all of the RDBMS, while the other LMS varied in which of the RDBMS they supported.

As we can see from Figure 6.15, the LMS that supported the most types of RDBMS were Moodle and OLAT, with 100% each, next came Sakai with 50% supporting only two RDBMS (MySQL and Oracle) and finally ILIAS supports only MySQL, with 25%.

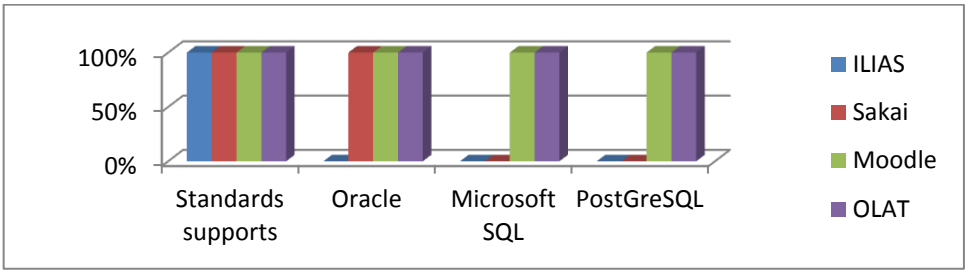


Figure 6. 15: Percentages of RDBMS supported by each of the LMS

After the second part of the evaluation, Moodle and OLAT were in the lead with an accumulated percentage of 100% each, Sakai had 76% and ILIAS 50% (see Table above).

6.3.3. Evaluation of LMS Standards and Specifications Compliance

In order to structure the information and content in different LMS and increase inter-operability, various specifications and standards have been developed, such as SCORM, IMS Global and AICC. Using such standards is very useful for giving a standard, stable, and efficient LMS. It increases the compatibility and helps to provide reliable learning content. Below, the researcher provides some brief information about the standards and the bodies behind them.

The AICC, the Aviation Industry CBT (Computer-Based Training) Committee, has been responsible for approving and providing the AICC Guidelines and Recommendations (AGRs) since 1988 (AICC, 1996b). The AGRs standardise the development, delivery and evaluation of computer-based learning and training (e-learning) (AICC, 1996a). The AICC has contributed hugely to the field of CBT and e-learning and this can be seen from their contributions, through various actions that have been translated into the AGRs, including the AGR-002, which is mainly a road map for CBT delivery, the AGR-006, which is a guideline for sharing data among Computer-Managed Instruction (CMI) with a LAN-based CBT courseware from different vendors, the AGR-009 which is a guideline that facilitates regulating user controls in CBT, AGR-010 which includes web-based learning and the AGR-012 which is a help

guideline and check list that aims to help individuals and firms when acquiring or developing CBT/WBT systems and content (AICC, 1996a).

SCORM: the Advanced Distributed Learning (ADL) Initiative introduced SCORM, which stands for Sharable Content Object Reference Model (Mackenzie, 2004; ADL, 2004; Emmanouilidis et al., 2008). Emmanouilidis et al. (2008) state that SCORM is the most widely-employed standard worldwide. According to ADL (2004), this is because it integrates "*a set of related technical standards, specifications, and guidelines designed to meet SCORM's high-level requirements—accessible, interoperable, durable, and reusable content and systems*". In other words, this means that SCORM can provide accessible learning content through different LMS platforms. Presenting such learning materials across different LMS platforms shows the inter-operable side of learning materials that are based on SCORM, while the ability to use the same or part of the e-learning materials on different platforms shows the reusability aspect of SCORM and the durability aspect comes from the fact that learners can use learning content without the need to redesign, reconfigure or re-programme it. Mackenzie (2004) emphasises the importance of using SCORM in LMS, saying that it is a standardised inter-operable way of dealing with learning content by combining different standards from different bodies such as IMS and the AICC to produce a complete model of the way learners interact and access learning content through LMS.

Moreover, Mackenzie (2004) describes the main role of SCORM as "*the SCORM focuses on the interface between content and the Learning Management System. In other words: how learning content gets into an LMS system, how it gets presented to learners, and how the learner's progress within that content is communicated to the LMS*". This is translated, according to Mackenzie, into six key high-level requirements: accessibility, adaptability, affordability, durability, inter-operability and reusability (Mackenzie, 2004). The main difference between SCORM 1.2 and SCORM 2004 (SCORM 1.3) is in the components.

Before discussing the IMS QTI, IMS Content Packaging (CP) and IMS Enterprise standards, the researcher would like to provide a brief introduction about the IMS Global body. IMS is a non-profit body that outlines and describes technical standards for learning technologies. The main focus of their work is to define and develop inter-

operability standards among LMS and other enterprise systems for the exchange of information (IMS Global Learning Consortium, 2010).

IMS QTI is an acronym for the IMS Question and Test Inter-operability specification (QTI). Smythe, Shepherd, Brewer, & Lay (2002) state that the main aim of QTI is "*the basic structure for the representation of question (item) and test (assessment) data and their corresponding results reports*". This means that the specification facilitates and permits the exchange of test information between different where such information contains the test itself and the results gained (IMS Global Learning Consortium, 2002b). The IMS QTI supports the implementation of different types of questions in the tests, such as Yes/No questions, True/False questions, likert scale questions and other formats of multiple choice questions (IMS Global Learning Consortium, 2002b). The difference between IMS QTI 1.2.1 and QTI 2 is mainly the enhancement of technical aspects. Such dense technical detail is outside the scope of this research. For more information, please visit (http://www.imsglobal.org/question/qtiv1p2/imsqti_litev1p2.html).

IMS Content Packaging (CP): This standard is considered to be the worldwide standard for the inter-operability of the creation of simple learning materials, using an authoring tool. IMS, similarly to AICC and SCORM, is the result of publishing learning materials into the form of a IMS content packaging file format, usually an XML file. IMS CP is a collection of content and learning objects (LO) (video, audio, pictures and text) presented in the form of PowerPoint slides, along with a navigational tool (IMS Global Learning Consortium, 2001 and revised in 2010). According to the IMS Global Learning Consortium (2001) the main aim of the CP is to offer the functionality to define and package learning materials. The main difference between IMS CP 1.1.3 and 1.1.4 is the enhancement of some technical aspects. Such technical detail is outside of the scope of this research. For more information please visit (http://www.imsglobal.org/content/packaging/).

IMS Enterprise: The scope of this specification is to support the inter-operability between LMS and other Enterprise systems used within the same institution, such as the Training Administration Systems and Student Administration Systems (IMS Global Learning Consortium, 2002a). According to the IMS Global Learning Consortium (2002a), this model is used to exchange information such as individual profiles, group

management, enrolment management and the final results of individuals and groups. The main reason the researcher considered this standard in the evaluation for this study is to cater for the possibility of any future transition to another LMS. In this case, the schools would find it easier to migrate their information. The table below demonstrates the standards and specification compliance of each of the evaluated LMSs.

Table 6. 3: Evaluation of LMS Standards & Specifications Compliance

Standards& Specification Compliance	**ILIAS**	**Sakai**	**Moodle**	**OLAT**
AICC	Y	N	Y	N
SCORM 1.3 (2004)	Y	N	Y	N
SCORM 1.2	Y	Y	Y	Y
IMS QTI 1.2.1	N	Y	N	Y
IMS QTI 2	Y	N	N	N
IMS Content Packaging 1.1.3	N	N	Y	Y
IMS Content Packaging 1.1.4	N	Y	Y	Y
IMS Enterprise	N	N	Y	N
Points	4	3	6	4
Total Accumulated Points	7	7	12	10
Total Accumulated Percentage	50%	50%	85.8%	71.4%

All four of the evaluated LMSs complied with SCORM 1.2 which represents 100%, IMS CP 1.1.4 is complied with by three out of the four LMS, four of the standards are complied with by two of the evaluated LMS, and the rest are complied with by a single LMS. This implies that SCORM 1.2 is the most commonly followed standard among all the standards considered in this research as it is supported by all the evaluated LMS.

Moodle clearly complies with the largest percentage of standards (6 out of 8, or 75%), OLAT and ILIAS both comply with 50% of the standards, while Sakai complies with 3 out of 8, or 37.5%.

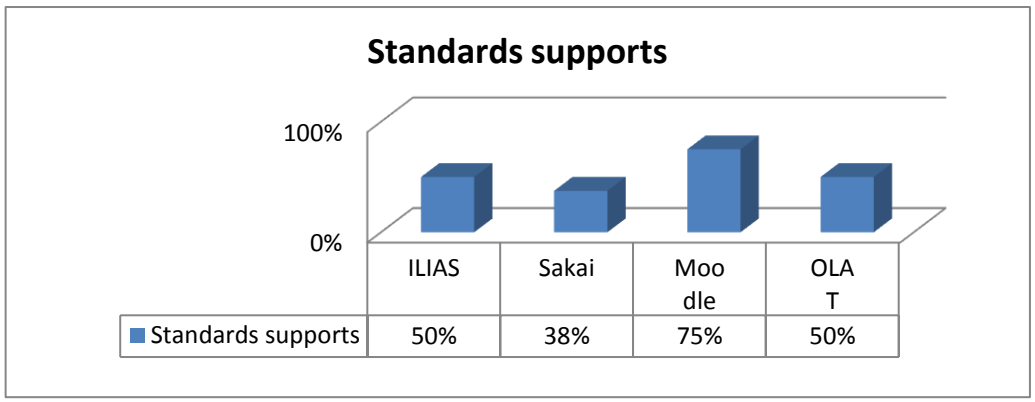


Figure 6. 16: LMS Support Percentage to the General Standard & Specification Compliance

At this stage of the evaluation, from the table above, it can be seen that Moodle is in the lead with 12 points so far (33%).

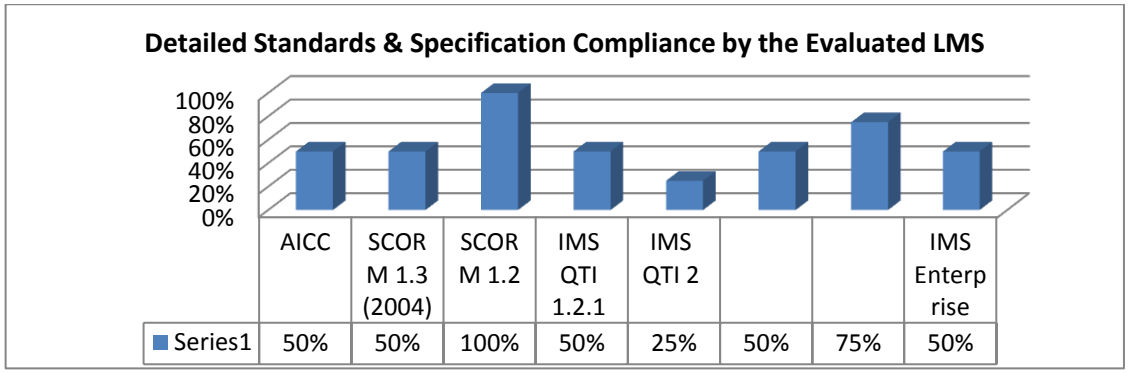


Figure 6. 17: Detailed Standards & Specification Compliance by the Evaluated LMS

6.3.4. Evaluation of Supportive Tools

The administrative tools are part of the group of so-called supportive tools and features that LMS provide for the administration of the system. Such tools include numerous features that help support the users (students, teachers, developers and administrators). They facilitate the access to learning materials and other services provided by the LMS. The kinds of services available are based on the user type and the permissions granted to him/her.

In the LMS context, the researcher takes administration tools to mean the tools that are available for administrating the LMS or those available to users with administrative permissions. The administrator manages the LMS via the administrative tools and available permissions. In addition, he/she can give visitor rights to all courses, authorise courses, and register users (integrated registration).

The main reason for evaluating the supportive tools and features is to ensure that both the researcher and the teachers will be able to make use of such tools. This will enhance the LMS' usability. The evaluated LMSs all provide most of these tools. However, based on the teachers' responses, the researcher evaluated certain key features including 'Integrated Registration', 'Approve Courses', 'Set Operations' and 'User Tracking'.

'Integrated Registration' gives teachers the ability to add their deaf students to their courses manually or allows the deaf students to register themselves. This issue arose during the interviews with the teachers. It was felt important to facilitate the deaf students' registration within the LMS, as some of them found it hard to register.

According to Edutools, such a facility is used to add and withdraw students from certain online course (edutools).

Approval of courses is a feature of all the evaluated LMS. This feature allows precise access permissions and privileges to be assigned based on user type and role, regarding the learning materials, content and tools. This tool is felt necessary as some of the teachers expressed the desire to be able to add new materials to learning content, such as new examples, or resources, or even modifying other teachers' learning content. It was also felt useful for the researcher to be able to add new resources.
The need for the 'Set Operations' feature is related to granting non-registered users access to the LMS. This includes the parents/guardians of the deaf pupils who requested access to the LMS in order to gain a sense of what their son/daughter was using. This would also be important as a means of capturing any comments or notes made by the parents/guardians. The key to this feature comes from preventing non-targeted users from participating in the research in an indirect way, which is, ensuring that their use of the LMS is not tracked and recorded as part of the main research. The feature needed to allow the teachers and the administrator (the researcher) to grant access to the parents/guardians without fear of their interference with the learning progress. The researcher granted access to the parents/guardians under the role of guest user. This allows them to access the LMS through a registered user name and a key or password.

'User Tracking' allows the LMS to track the activities of users with different user roles while they are using the LMS. Administrators can use this feature to generate statistical information about the use of the system, number of users, number of courses, etc. on both usage levels (individual and collective). The teachers can use it to track his/her students' progress in his/her courses, and learning content, grades and examination results, etc., again on both usage levels. Students can track their progress, grades, course usage and learning materials.

'Course Management' allows the teacher to control the progress and access to the learning content, by preventing or allowing the student access to the next topic. This could be based on finishing the current content or fulfilling certain tasks or criteria.

Table 6. 4: Supportive Tools Evaluation

Supportive Tools	**ILIAS**	**Sakai**	**Moodle**	**OLAT**
Integrated Registration	Y	Y	Y	Y
Approve Courses	Y	Y	Y	Y
Set Operations	Y	Y	Y	Y
User Tracking	Y	Y	Y	Y
Course Management	Y	Y	Y	Y
Points	5	5	5	5
Total Accumulated Points	12	12	17	15
Total Accumulated	63.1%	63.1%	89.4%	78.9%

Regarding the evaluation of the administrative and supportive tools, all LMS were equal and gained the same number of points. In total, this did not change the positions of the LMS. Moodle remained in the lead followed by OLAT.

6.3.5. Evaluation of Customisability

The term customisation can be applied to many aspects and layers of software and computer applications and can be used and viewed in different ways (Werner, 2010). According to Kerkiri & Paleologou (2009), the term customisation is "*the simplest form of adaptation, and it refers to the ability of the users to modify the page layout or specify which links in a page should be displayed as well as how the content should be displayed*". Customisability can refer to adding or removing services, general appearance and functionality to suit the needs of end users and institutions.

According to Weiss, the customisability of LMS is a major concern because the available LMS in the market (commercial and open source) are "off the shelf" (Weiss, 2009) and come in the standard format of the supporting body. Weiss argues that customising an LMS will have two key consequences that are time and cost, for the implementation. The time factor will affect the date of installation in the case of new implementations and could cause the service to be shut down in the case of an already implemented LMS (Weiss, 2009). However, Werner argues against Weiss' ideas, advising changing the delivery process itself, instead of changing the LMS (Werner, 2010).

According to Werner (2010), customisation can apply to different facets of an LMS, such as its look and feel, adding existing features and tools from the market, such as

new communication tools or new languages, or adding new features and services entirely to existing LMS.

Geczy, Izumi, Akaho, & Hasida (2008) define personalisation as "*adjustments of system functionality according to user preferences and browsing characteristics*". Thus, they concur with Geczy et al. (2008) who define personalisation as making modifications and adaptations to the LMS. However, the term personalisation can imply different meanings in the LMS world. Personalisation can be on a personal, individual level or an institutional level. It can also be applied to the learning content, communication tools, or the supportive and administrative tools (Kerkiri & Paleologou, 2009).

Kerkiri & Paleologou (2009) distinguish between the three terms adaptation, personalisation and customisation, describing LMS customisation as "*the simplest form of adaptation*", which is the ability of the users to make some modifications to specific features such as how the LMS looks and feels, adaptation as the ability of the LMS GUI, features, services and navigation tools to accept modifications, and personalisation as the ability of the LMS to present learning content based on the users' learning preferences.

The importance of personalisation comes from the fact that the individual learners differ in terms of their skills, abilities and preferences when learning (or differences in their learning traits), where such differences might also be affected by conditions such as deafness and blindness (Jonassen & Grabowski, 1993).

As the research takes place in the Hashemite Kingdom of Jordan, having an LMS that supports the Arabic language is vital, as the end users use Arabic. The teachers' first language is Arabic and their deaf pupils' first language for reading and writing is Arabic, although they use other communication methods as well, such as sign language, lip-reading and total communication methods. Multilingual support is thus included in the evaluation, under the assumption that LMS will be used in other courses, such as teaching English language, in the future.

In this part of the evaluation, most of the evaluated LMS scored similar results in the key requirements. However, Moodle maintained its position in the lead. As we can see

from Table 6.5, three out of four of the evaluated LMS support Arabic. This will reduce the choice to just these three.

Table 6. 5: Evaluation of the LMS Customisability

LMS Customisation	ILIAS	Sakai	Moodle	OLAT
Personalisation	Y	Y	Y	Y
Support Arabic Language	N	Y	Y	Y
Multilingual Support	Y	Y	Y	Y
Points	2	3	3	3
Total Accumulated Points	14	15	20	18
Total Accumulated Percentage	63.6%	68.1%	90.9%	81.8%

6.3.6. Evaluation of Collaboration and Communication Tools

LMS collaboration and communication tools are one of the main aspects that enable interaction among LMS users. These tools reflect the modes of communication and collaboration available to the users. If a LMS provides a variety of communication tools, users will find it easier to approach each other and their teachers, and, in this case, the deaf users need more ways to communicate and collaborate, especially through tools that offer quick feedback in a visual way. Visual means of communication are important when dealing with users who are deaf, who generally communicate through means such as sign language, lip-reading and total communication, which is also a visual language. The most important communication tool is the video-based one, which enables them to communicate using sign language or lip-reading. This does not mean that other communication tools are not important.

Using video communication is a suitable method of conveying Jordanian Sign Language to explain concepts during synchronous learning. Using such tools in conjunction with illustrations, animations and texts will enhance the learners' motivation and improve their understanding of the content (Khwaldeh, Matar, & Hunaiti, 2007).

According to Long, Vignare, Rappold, & Mallory (2007), communication tools such as e-mail, chatting (instant messages), forums and video-conferencing will help deaf pupils to interact and communicate with their peers and hearing teachers. They thus help to create a permanent and manageable learning experience.

When learning takes place in a class using conventional teaching methods, deaf pupils face difficulties in learning due to problems with communication. For example, where lip-reading is the main means of communication, when the teacher demonstrates a concept on the blackboard, they usually face away from the students, making lip-reading impossible. Also, if a teacher who is not fully skilled in sign language uses a sign language interpreter there will be a lag between the teacher's delivery of the learning content and materials and the signed delivery by the interpreter (Long & Beil, 2005). Moreover, deaf learners often have a problem keeping up with what their teachers are saying in either of the two examples given above. Unless they have a note-taker, they will not be able to write down the necessary information and watch the lecturer/interpreter at the same time.

Collaboration and communication tools in both synchronous and asynchronous modes of learning, enable the exchange of ideas and the sharing of knowledge among the users, which will result in a community of learners being formed (Long et al., 2007). Moreover, such tools have been shown to facilitate the communication between the deaf and their families, colleagues and co-workers (Hanson, 2008).

Table 6. 6: Evaluation of Collaboration and Communications Tools

LMS Communication Tools	**ILIAS**	**Sakai**	**Moodle**	**OLAT**
Forum	Y	Y	Y	Y
File Exchange	Y	Y	Y	Y
Internal Messages	Y	Y	Y	Y
Notes	Y	Y	Y	Y
Chat	Y	Y	Y	Y
Video Conference	N	N	Y	N
Whiteboard	N	Y	Y	N
Points	5	6	7	5
Total Accumulated Points	19	21	27	23
Total Accumulated Percentage	65.5%	72.4%	93.1%	79.3%

As can be seen from the above table, only LMS supports video communication is Moodle. This gives Moodle an advantage over the other LMS. Moreover, all of the evaluated LMS support communication tools among users, whether they are instructors, administrators, or students. The forum tool and the file exchange facility are both supported by all the LMS.

6.3.7. Evaluation of Assessment Tools

Assessment tools are a very important aspect of LMS as they reflect the achievements (grades or marks) that have been made through using the LMS and by accessing the learning content provided by the LMS.

Assessing the type of questions available concerns the ability of the LMS to generate different types, such as yes/no questions, multiple choice questions, true/false questions, fill-in-the-blank questions and matching questions. The alternative would be for the author to create such tests using third party software, such as QuizCreator. Moreover, automated system testing, scoring and support is a system that generates questions from a questions database, marks the student responses based on predefined answers provided by the teacher or author of the test and, finally, supports the student through feedback, either immediately following each question or on completion of the whole test.

'Online Grade Book' is a feature providing grades to users based on their roles. For example, teachers have them for all the courses they are teaching and all their students. On the other hand, the students have access to all the grades they have achieved in all the courses in which they have been enrolled.

Table 6. 7: Evaluation of Assessment Tools

LMS Assessment Tools	**ILIAS**	**Sakai**	**Moodle**	**OLAT**
Question Types	Y	Y	Y	Y
Automated Testing, Scoring, and Support	Y	Y	Y	Y
Online Grade Book	N	Y	Y	Y
Points	2	3	3	3
Total Accumulated Points	21	24	30	26
Total Accumulated Percentage	65.6%	75%	93.7%	81.2%

Most of the LMS evaluated provided assessment tools. The only variation was that ILIAS did not support online grade books.

After the complete evaluation, Moodle was the only LMS to meet the developed key requirements, with a total score of 30 out of 32 points, which is about 93.7%. This was based on the evaluation of the results and meeting the key requirements which was

based on hardware/software, RDBMS, standards support, supportive tools, the customisability, the collaboration and communication tools and the assessment tools.

6.4. SUMMARY

After completing of the evaluation, Moodle scored highest number of points (30 out of a possible 32). It also supports video-conferencing and fully supports the Arabic language. Therefore, Moodle was chosen to assess deaf pupils in Jordan in the next stage of the research.

The evaluation of the LMS involved examining many factors in relation to the key requirements, split into various categories, such as language support, hardware/software specifications, RDBMS, LMS standards and specifications compliance, administrative tools, assessment tools, collaboration and communications tools, and customisability.

From a technical point of view, it was found that the existing open source LMS are suitable for adaptation to support deaf learning in the classroom. This can be assessed further through the evaluation of the cognitive impact and usability of such systems during teaching. To achieve this, next, an evaluation programme involving teachers/instructors and deaf pupils in five Jordanian schools was performed. It is hoped that the successful completion of this programme will open the way to providing a complete support system for the education of deaf pupils in Jordan.

In the following chapter, the researcher will describe the procedures carried in term of implementing Moodle within the participating schools for the deaf.

CHAPTER 7

IMPLEMENTATION OF MOODLE

7.1. INTRODUCTION

In this chapter, the procedures followed in order to implant the chosen Open Source LMS "Moodle" within the Jordanian context are described. The results described in Chapter 5 showed the lack of use of LMS and e-learning in Jordanian schools for the deaf. Moreover, it presented the end user requirements from the teachers' perspectives, based on what they think they currently lack when carrying out teaching activities in the classroom. The evaluation described in Chapter 6 led to the adoption of Moodle (Open Source LMS) which will act as a technological platform to assist schools of the deaf, teachers of the deaf and their pupils in deaf learning and aim to encourage better use and adoption of LMS and e-learning in Jordan. Part of this process has contributed in providing recommendations on implanting LMS and e-learning systems in similar contexts in the region (the Arab region) and other parts of the world.

In this chapter, the main focus is to illustrate the steps that were taken to implement "Moodle", to satisfy the requirements of the main users (instructors and students) and the educational institutions, in a way that avoided stirring up resistance to this type of solution. Finally, the steps adopted in conducting the research are also described.

7.2. Implementation Strategy: Implementing the LMS and E-Learning System

The methodological approaches followed in implementing the LMS and e-learning system were based on the Waterfall System Development Life Cycle **(**SDLC**)** model (Avison & Fitzgerald, 2003). This model was chosen for the lucidity and simplicity of its sequential design. Moreover, Sen and Sinha (2005) indicate that the Waterfall SDLC model can be used as an implementation strategy. Finally, the Waterfall SDL complies with the Action Research. The following diagrams show the Waterfall SDLC and the Action Research cycle.

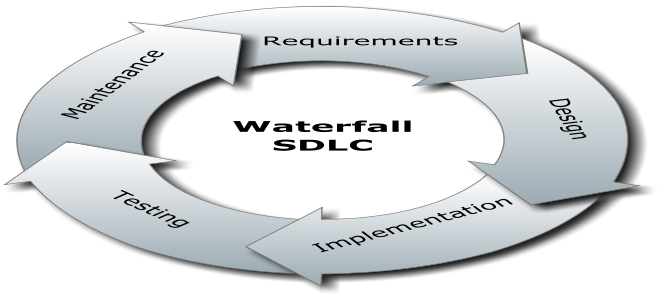


Figure 7. 1: Waterfall System Development Life Cycle (Sen & Sinha, 2005)

The waterfall model is commonly used in software development. In the model, the requirements are well defined. Five phases were used in this study. However, the term Adoption was used within the design phase. This is because of the evaluation process explained in Chapter 6 in which an open source LMS was adopted.

Figure 7. 2: Action Research cycle (Baskerville, 1999)

Comparing the two cycles, the similarities between the processes involved in each cycle can be seen. In the Action Research cycle, the cycle starts with **diagnosing** the problem, which means studying the problem through planning, collecting, analysing and processing data, resulting in understanding the **requirements** (which is the first phase of Waterfall SDLC) of the end users (MEDA-ETE, 2009). The second phase in the Action Research cycle is **action planning**, which includes the **design** (Waterfall SDLC, second phase) of an alternative action plan. The third phase in the Action Research cycle is **taking action**, which means selecting a course of action and **implementing** it (Waterfall, third phase). The fourth phase of the Action Research cycle is the **evaluation** of the chosen course of action by **testing** (Waterfall, fourth phase) that course and studying the results and consequences of the action. The final phase of the Action Research cycle is **specifying learning** (findings), which will either lead to another cycle or to a solution. However, in both scenarios it is important to carry out **maintenance** (Waterfall, phase five) of the results achieved.

7.3. Approaching the Ministry of Education and the Schools in Jordan

In order to conduct this research, the researcher worked closely with Mathematics teachers of the deaf pupils. In order to do this, contact with the MOE in Jordan was made. From the initial telephone conversation there was a positive response (October 2008). Based on this, a visit to Jordan was undertaken to explain the project to the MOE and request permission to access and introduce the project to the schools. The MOE granted the researcher permission to access all deaf schools in Jordan in order to conduct this research (see attached copy).

Next, an invitation to the schools of the deaf in Jordan was sent out, via the MOE, to participate in this project. The invitations were sent to head-teachers and then passed onto the teachers. Five schools responded to the invitation and expressed a keen interest in participating.

After this, five schools for the deaf were visited and introduced the project to the teachers and their deaf pupils, via an information session. A range of materials /activities were used to explain the purpose of the project, including time line posters, a questions and answers round table, and information sheets for the teachers. Moreover, the researcher attended classes where the project was explained to the pupils through the teachers and interpreters.

7.3.1. Participants and Participation

The participants were deaf pupils aged between eight and ten years old and their teachers. The teachers at the participating schools all work for the MOE. The sample size of participating deaf pupils across the five schools was 75. 65 teachers of the deaf were involved in the project, including fifteen mathematics teachers. The total sample size was thus 75 pupils and 65 teachers.

Participation was on a voluntary basis, with permission given by signing a consent form after receiving information about the project. Initial discussions with the teachers of the deaf allowed the researcher to explain the project to the teachers. Moreover, the researcher asked the teachers to explain the project to the pupils. This helped the

researcher to sort out some scenarios that might occur during the implantation phase, for example:

- **Case 1** (pupil wants to participate but their parents/guardians do not want them to): In this case, the researcher tried to encourage the parents/guardians and talked to them about the benefits of the project for their child, but if they insisted that they did not want their child to participate, the researcher did not include them in the project.
- **Case 2** (pupil does not want to participate but their parents/guardians do want them to): In this case, the researcher tried to encourage the pupil through the teacher/interpreter, asking the teacher/interpreter to inform the child about the benefits of the project, but if the pupil insisted that he/she did not want to participate, then they were not included.
- **Case 3** (pupil and parents/guardians do not want to participate): Due to the nature of the project, which is using LMS and e-learning as a tool to supplement the conventional approach, the pupils could continue attending class as normal, without participating in the project.
- **Case 4** (pupil and parents/guardians withdraw during the study): In this case the pupils were able to continue their class as normal without using the LMS and e-learning access.

The researcher discussed such scenarios with the teachers to ensure that the children who did not use the LMS and e-learning tool were not disadvantaged.
The researcher recognised the potential vulnerability of the children, particularly the deaf children, and the adults (teachers). The researcher acknowledged the fine balance between the need for privacy and the need for openness to public scrutiny in order to assure the personal safety of potentially vulnerable children/adults. The risk to pupils and teachers in this project was deemed to be very low.

The researcher expected some potential risks to the teachers and the children when trying out Moodle, such as that they could become confused and anxious due to a lack of skills in using the computer and ICT tools. However, to overcome such concerns and scenarios, the researcher conducted discussions with the teachers and also workshops

and seminars with the teachers and the deaf pupils about the use of the ICT tools and "Moodle".

7.3.2. Participation Procedures

Participants were provided with a participation letter and the teachers were briefed in person by the researcher and the pupils through the teachers. Participants were asked for informed consent in writing before any data or quotes were gathered for research purposes. Participants were assured that they could withdraw at any time without prejudice. They were also given the opportunity to receive feedback on the findings and a copy of the final report if requested.

The researcher used coloured cards to determine the pupils' initial desire to participate in the study. The pupils were each given two coloured cards (one green one red), and told to raise the green card if they wanted to participate. This step was used to ascertain genuine approval about participating in the project. The pupils were given the red card to raise either at the beginning if they did not want to participate, or if they wanted to withdraw at any time during the study.

The researcher followed certain steps in seeking informed consent from the participants. In seeking to involve deaf pupils as research participants, the guidelines proposed by Priscilla Alderson (Personal conversation in 2007) were followed, such as privacy and confidentiality, using consent forms, appreciating the impact on the children, and dissemination. Participating children and their families received detailed, advance information about the project, its purpose and its potential outcomes.

Informed consent was obtained from at least one person with parental responsibility for the pupil and the pupil as well. In the case of a pupil wishing to participate but their parents/guardians withholding consent, the researcher sought to discuss the issue with them, although the parents/guardians had the final veto. The wishes of children who did not want to be involved in spite of their parents/guardians' agreement were respected as well.

Another step was taken by recording the consent through a signed and dated consent form with each party involved, i.e. the children, the children's parents/guardians, and

the teachers. Moreover, the participants' confidentiality and anonymity were ensured through several steps: no data were stored with names attached; interview and questionnaire data were recorded by number and a list connecting the number to a person was stored in a separate secure place; participants were not referred to by name in the research report; the conditions of the Data Protection Act were adhered to; manual files (e.g. paper documents) were stored in a locked cupboard or, when in transit, in a locked briefcase; all electronic data, whether stored on a personal laptop computer or university computer, were password protected.

Another step taken was to obtain a clearance letter from the criminal records bureau in the UK, stating that the researcher had passed a criminal check. This step was taken to provide confidence to the participants about the researcher's background. Moreover, it insured the University of Central Lancashire and the researcher against any potential issues that might arise.

7.3.3. Risks

This section describes some of the risks anticipated while conducting the project and the ways to deal with them:

- *Potential Risks to the Participants*

  The semi-structured interviews with the teachers and their completion of the questionnaires were carried out in public places or rooms with windows. All data were anonymised for reporting purposes and held under the British Data Protection Act and participants were able to withdraw from the project at any time without prejudice. Moreover, the researcher offered training workshops for the teachers so that they could use Moodle and trained the children to use such technology to overcome their lack of experience of using ICT. On the occasions when the researcher attended a classroom, he stayed at the back of the classroom to avoid attracting the pupils' attention and did not interfere unless there was an issue regarding the use of the LMS and e-learning.

- *Potential Risks to the Interests of the Researcher*

  To mitigate potential risks to the researcher's interests, and because of the endless scenarios, the researcher held further discussions with the teachers and ensured that all participants and parents/guardians were fully informed about the

project and its progress. These steps were aimed at keeping any anxiety to a minimum and reducing the possibility of parents/staff becoming aggressive.

7.3.4. Access to the Participating Schools

Having gained permission from the MOE to access all schools in Jordan, five schools for the deaf were visited to conduct the project. One of the main things noticed was that, although the schools had computers, they were being used very little for teaching purposes.

The need to understand the approaches used in teaching deaf pupils were recognised, particularly with respect to their learning of mathematics. Working with the teachers, the researcher firstly aimed to understand the problems facing the children when learning some specific areas of mathematics and to ascertain the existing use of ICT and e-learning in the classroom, which was done through conducting semi-structured interviews and distributing questionnaires (see Chapter 5).

Having reflected on the findings, which included the teachers' requirements of the LMS and e-learning system, the researcher evaluated four open source LMS and e-learning systems and adopted one of them, "Moodle" (see Chapter 6). This was then used by the teachers and their deaf pupils. It is important to note that the researcher first conducted seminars and workshops for the teachers to introduce Moodle so that they could test it and then later used by the deaf pupils.

7.3.5. Defining the Requirements and Criteria

In this part, a reminder is provided of the criteria that were gathered from the teachers' responses and described in Chapter 5. Analysing these requirements contributed to the selection of the open source LMS "Moodle" through an evaluation of four open source LMS as described in Chapter 6.

- *The LMS and e-learning system should be accessible anytime/anywhere through the use of the Internet*.

  The justification for this requirement is that all the participating schools in this study are connected to the Internet. This shows a clear indication that the MOE in Jordan and the schools themselves are emphasising the use of the Internet

and ICT tools in their teaching activities. Moreover, this shows the importance of extending the learning resources available to the schools, teachers and pupils. Access via the Internet will enable the pupils to use the learning content and materials anytime/anywhere.

- *The LMS and e-learning system should not replace the teacher but should act as a complementary and supplementary system to enrich their teaching and provide more resources and more tools to be used with more learning resources.*

  The main players in a learning activity are the teachers and the students and the LMS and e-learning system cannot replace the teacher's role in the classroom but can aid them by providing supplementary tools that can enhance their teaching (Blended Learning). Moreover, the literature shows that the use of LMS and e-learning systems has proved to be successful in managing education.

- *The LMS and e-learning system should provide the ability to import external learning resources (web sites and other files such as PowerPoint slides and video-based materials).*

  This requirement is due to the lack of development of specialised learning content that suits deaf learners' specials needs. The system should allow the users to import external learning resources. For example since mathematics is a universal language, this will save the time/cost of developing new learning content that already exists (Cochrane, 2005).

- *The LMS and e-learning system should support different collaborative tools to ensure better communication and the ability to share resources*

  This requirement is due to the special needs of deaf pupils and their difficulties collaborating and communicating among themselves and with others, including their teachers. There is a crucial need to support different types of collaboration, such as online chat, instant messaging, video-conferencing, web conferencing, synchronous conferencing and e-mail, within the learning environment in order for the deaf pupils to fully embrace the possibilities available.

7.4. The System and its Functionalities

In this part, a description of Moodle is given along with the sorts of functionalities that have been used, such as user type, course format and content access.

7.4.1. System Description and Moodle Tiers

The Moodle website (2010a), Cole & Foster (2008) and Rice (2006) define Moodle as a LMS, a Virtual Learning Environment (VLE) or a Course Management System (CMS). Moreover, Moodle is considered to be a leading open source e-learning platform. Moodle stands for Modular Object-Oriented Dynamic Learning Environment (Khwaldeh, Shah and Ahmed, 2011). The Moodle platform used in this research includes the following aspects:

- The Moodle platform infrastructure that has been used in this research is flexible enough to support future system growth, including 2.5 GB of storage space to accommodate learning materials, supporting up to 2,500 users, and having 50GB of bandwidth. This is the so-called *scalability* aspect of e-learning dependability, described by Al-Dahoud et al. (2008).
- The platform supports major learning standards such as the Sharable Content Object Reference Model (SCORM), IMS and AICC, which improves the *interoperability* (another aspect of dependability) (Al-Dahoud et al., 2008). This aspect is concerned with how well a LMS complies to certain standards needed for sharing instructional materials with other LMS.
- The platform supports the diverse needs of all types of users (administrators, teachers, students and guests), through the use of add-ons that extend its functionality, such as Skype and Sloodle. This is referred to as *availability*, again one of the e-learning dependability aspects, by Al-Dahoud et al. (2008).

- The platform also supports Al-Dahoud et al.'s (2008) *security* aspect of e-learning dependability. Moodle uses a security system that helps to protect against identity theft or system misuse by unauthorised users. Although the *security* aspect is important for any LMS and e-learning system, it is outside the scope of this research.

According to Al-Dahoud et al. (2008), all modern e-learning platforms contain three tiers of Internet applications or architecture. Moodle consists of a user interface (UI) tier, a web server tier and a database server tier. The following figure illustrates all three tiers.

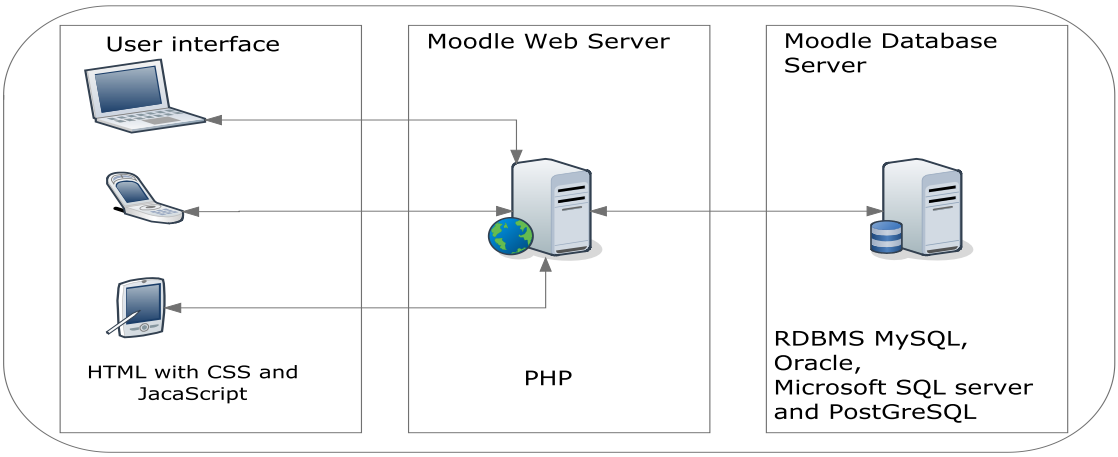


Figure 7. 3: The adopted LMS Moodle's Tiers (Khwaldeh et al., 2011)

- ***User Interface Tier:*** this tier includes all the interfaces used to communicate with the second tier. It consists of both software and hardware. The software comprises of the internet browsers that read the HyperText Markup Language (HTML), composing documents and presenting them into visual web pages. Cascading Style Sheets (CSS) are used to handle the look and formatting of HTML documents. Java Script is used to provide enhanced and interactive interfaces. The hardware enables the use of the software. The main aim of this interface is to establish a form of interaction between the users and the system.
- ***Moodle Web server (Application Tier)***: in this tier, the Hypertext Pre-processor (PHP) programing language is used to allow the user to control one or more applications. This language is interpreted by the Moodle web server via a PHP processor that produces a web page. In this tier, user requests, made through his/her permissions, are performed, allowing him/her to make use of the system.
- ***Moodle Database Server (Database Tier)*:** this tier contains all the data from the application tier. This includes all the data generated through the users' activities, such as users' profiles, learning content, and users' actions. It is stored in a database server, which is computer software that makes database services available to other computer applications.

7.4.2. User Types

Moodle offers various different user types. In this research, three user levels will be discussed although, there are more than this available, as illustrated in the following table.

Table 7. 1: Different Roles in Moodle, from Moodle system description

Name	Description
Administrator	Administrators can do anything on the site, in all cases.
Teacher	Teacher Teachers can do anything within a course, including changing the activities and grading.
Student	Students generally have fewer privileges within a course.

In this research, the main focus is on system administration, teachers/instructors and students. Each type of user is granted different privileges, tools, and permissions. Each one of these levels interacts with the other roles. A simple flowchart of accessing Moodle is illustrated in Figure 7.4.

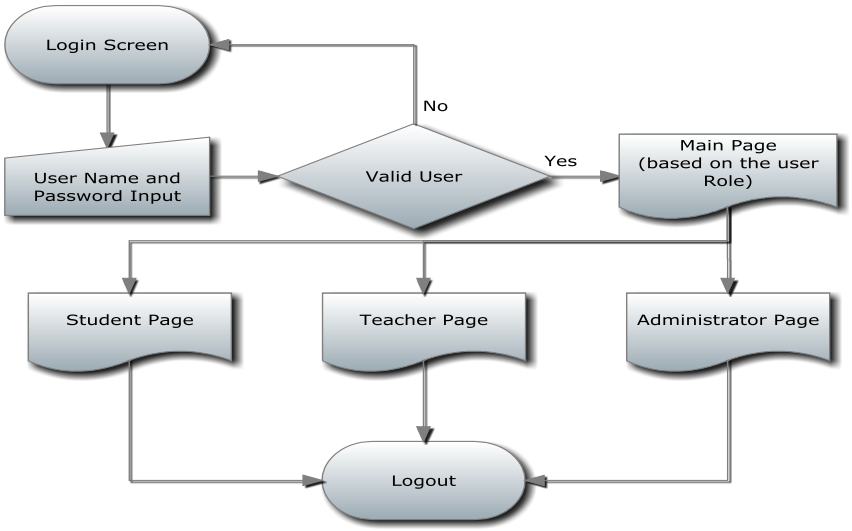


Figure 7. 4: Simple Flowchart of Accessing Moodle

7.4.2.1. System Administration

This may consist of single person or a team of administrators (Khwaldeh et al., 2007). The team of administrators might consist of a group of individuals with different professional skills, including an information and communications technology expert, an instructional designer, experts in pedagogical issues and communication experts. In the Moodle system, the main role of the administrator is to track Moodle functionalities, set

permissions and privileges for other users, such as teachers and manage the course structure based on the teachers' recommendations or another responsible body.

The administrator manages Moodle through the administration tools provided by the system. In addition, they can communicate with teachers/instructors and pupils. In this research, the administrators (the researcher and three other teachers) were communicating with the teacher exclusively.

The administrators had privileges that allowed them to create and manage the course structure and choose the sort of tools that should be used, such as instant messages (chatting), e-mails, forums, etc. Moreover, they were able to import learning content from external sources, upload data, download or export data uploaded by the teachers/instructors and the pupils, view the uploaded data, alter it if necessary, and remove data (Khwaldeh et al., 2007).

The administrative account facilitates the management of course structures. Creating the course structure is mainly done in conjunction with the teachers/instructors. This begins with defining the resources that should be used, grouping them into topics or lessons, forming these into chapters and ordering chapters into a course (Matar et al., 2008).

As an administrator in this research, the responsibility for creating course structure was one of my duties, which the researcher carried out with the help of the teachers/instructors. The choice of appropriate tools and content was mainly the responsibility of the teachers/instructors.

Another duty for the administrator is to manage the users. This enables them to control precisely the other users' access to the content and to the whole system in general. This includes the creation of user names and approving self-registration by others. The administrator can also assign roles to other users, including allowing them to act as administrators in specific situations (in this research, the researcher granted teachers the ability to act as administrators in terms of approving the registration of their pupils in Moodle.

It is important to note that these are not the only privileges available on the administrator account in Moodle. The following table gives a wider description of the tools, privileges and actions that can be accessed by administrators.

Table 7. 2: Actions Related to the System Administrator Role within the Moodle Environment.

Administrative tools and Privileges	Action
Users	• Manage All User Profile (Edit, Delete, add or Authorize) • See All User Posts • See All User Blog's
Course	• Mange blog entries • Mange participants • View scales: Scales are a way of evaluating or rating a students' performance. • View user profiles • Add/ remove attendees • Add, edit, copy and delete face-to-face sessions • View cancellations • Manage attendance list and attendees • Manage Course (Name, ID, Summary, Activities, Groups, delete, (Hide/Show)) • Manage grades (edit, hide, Export, import)
Grade book	• View the overview report • View Students grade report • Export and import Student/s Reports
Course reports	• View course logs • View live logs • View course activity report • View course participation report • View course statistics report
Assessment & Assignment	• Manage assessment • Manage assignment • View assignment report • Grade Assignment (if he/she is a teacher)
Chat	• Create a chat room • Access a chat room • Delete chat logs • Read chat logs
Dimdim Web Meeting	• Manage Dimdim Web Meeting (access, read, create and delete)
Feedback	• Manage Feedback (View, Edit, Create, Delete) • Manage Feedback templates (Edit, Create, Delete)
Forum	• Create attachments • Delete own posts (within deadline) • Manage any posts (any time) (Delete, Edit, move) • Initial subscription • Reply to posts • Split discussions • Start new discussions • View discussions
Workshop	• Manage workshop
Student Info	• Edit My Fields • Edit all Fields • View student info • View class
Lesson	• Manage lesson activity (edit, delete)
Reports	• View course overview report
Online Users	• View list of online users

From the above table it is quite clear that administrators are concerned with managing users' data and all related issues, managing courses, and managing the communication and collaboration tools.

Managing the collaboration and communication tools is another way in which administrators manage the system. These tools enable the administrator to communicate with the teachers. The following figure shows the Administrators' Main Page.

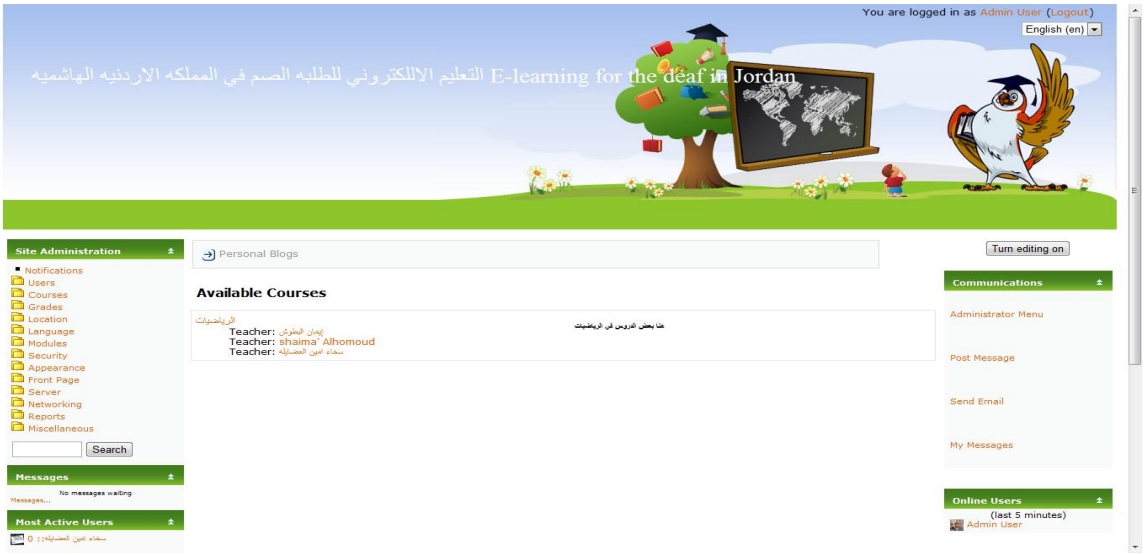


Figure 7. 5: Administrators' Main Page after Login

The following figure shows the Administrative Panel (or Block) that allows the administrator to manage Moodle.

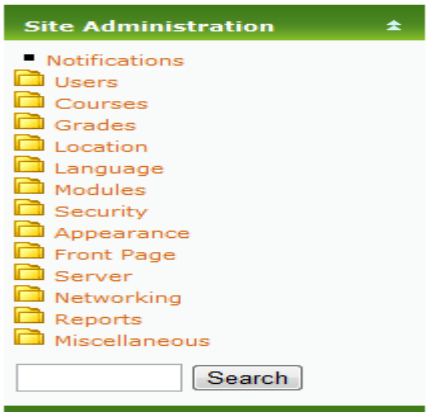


Figure 7. 6: Administrative Block or Panel.

7.4.2.2. Teachers/Instructors

According to Sutherland & Balacheff (1999), effective teaching requires excellent tutors who are able to get involved in the pupil's learning process. The teacher/instructor decides on the educational material that needs to be used within Moodle. They also decide on the way in which the material will be presented to the

pupils and what collaborative tools should be used in the course. The teacher/instructor is also able to create, upload, and download learning content in accordance with the syllabus and the learning objectives. Moreover, they can download learning content uploaded by other teachers/instructors, view other teachers' learning content, and modify their own uploaded learning content. However, the teachers/instructors account has limited administrative permissions compared to the administrator account. Table 7.3 illustrates the tools available to teachers/instructors.

According to the *Student Guide for Using Moodle*, Moodle is structured around the concept of courses. In order to use this in the context of this research, the researcher held collaborative sessions and workshops with the teachers in order to gather different ideas and methods to be used in the courses and the main concerns and recommendations regarding course structure and topics (Moodle, 2006).
The following figure shows the Teacher/Instructor Main Page.

Figure 7. 7: Teacher/Instructor Main Page after Login.

The following figure shows the Teacher/Instructor Administrative Panel or Block that allows the Teacher/Instructor to Administrate Moodle if they have been granted such privileges.

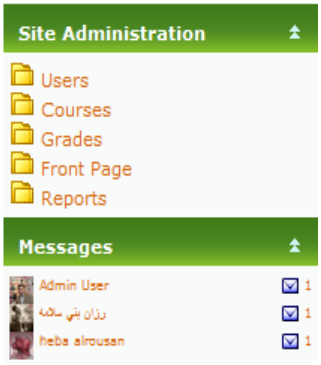


Figure 7. 8: Teacher/Instructor Administrative Panel or Block

Table 7. 3: Actions Available to Teachers/Instructors within the Moodle Environment

Teacher/instructor tools and Privileges	Action
Users	• See All User Posts • See All User Blog's
Course	• Manage blog entries • Manage participants • View scales: Scales are a way of evaluating or rating a students' performance. • View user profiles • Add/ remove attendees • Add, edit, copy and delete face-to-face sessions • View cancellations • Manage attendance list and attendees • Manage Course (Name, ID, Summary, Activities, Groups, delete, (Hide/Show)) • Manage grades (edit, hide, Export, import)
Grade book	• View the overview report • View Students grade report
Course reports	• View course logs • View live logs • View course activity report • View course participation report • View course statistics report
Assessment & Assignment	• Manage assessment • Manage assignment • View assignment report • Grade Assignment (if he/she is a teacher)
Chat	• Access a chat room • Delete chat logs • Read chat logs
Dimdim Web Meeting	• Manage Dimdim Web Meeting (access, read, create and delete)
Feedback	• Manage Feedback (View, Edit, Create, Delete) • Manage Feedback templates (Edit, Create, Delete)
Forum	• Create attachments • Delete own posts (within deadline) • Manage any posts (any time) (Delete, Edit, move) • Initial subscription • Reply to posts • Split discussions • Start new discussions • View discussions
Workshop	• Manage workshop
Student Info	• Edit My Fields • Edit all Fields • View student info • View class
Lesson	• Manage lesson activity (edit, delete)
Reports	• View course overview report
Online Users	• View list of online users

7.4.2.3. Pupils or Students

The pupils were able to choose which tools they used during their access of the learning content (chatting room, forums, Dimdim, topics during asynchronous access). Additionally, the pupils were able to access the educational content uploaded by the teacher/instructor and were able to interact and ask questions of the teacher/instructor during synchronous or asynchronous modes through the use of communications tools. Moreover, they were able to browse the learning content based on the sequence that had been set up for them by the teachers/instructors. The pupils' accounts had limited permissions compared to those of the teachers/instructors and administrators. The following table shows some of the actions available to them.

Table 7. 4: Actions Available to Pupils/Students within the Moodle Environment

Pupils tools and Privileges	Action
Users	• See All User Posts • See All User Blog's
Course	• Sign-up for session • view Blog entries • View scales: Scales are a way of evaluating or rating a own performance. • View user profiles • view own grades
Grade book	• View the overview report • View own grade report
Course reports	• View course logs • View live logs • View course activity report • View course participation report • View course statistics report
Assessment & Assignment	• submit assessment • submit assignment • View assignment report
Chat	• Access a chat room
Dimdim Web Meeting	• Access and Read Dimdim Web Meeting
Feedback	• View Feedback
Forum	• Create attachments • Delete own posts (within deadline) • Initial subscription • Reply to posts • Start new discussions • View discussions
Workshop	• Participate in a workshop
Student Info	• Edit My Fields
Lesson	• Manage lesson activity (edit, delete)
Attendance	• View Attendance
Online Users	• View list of online users

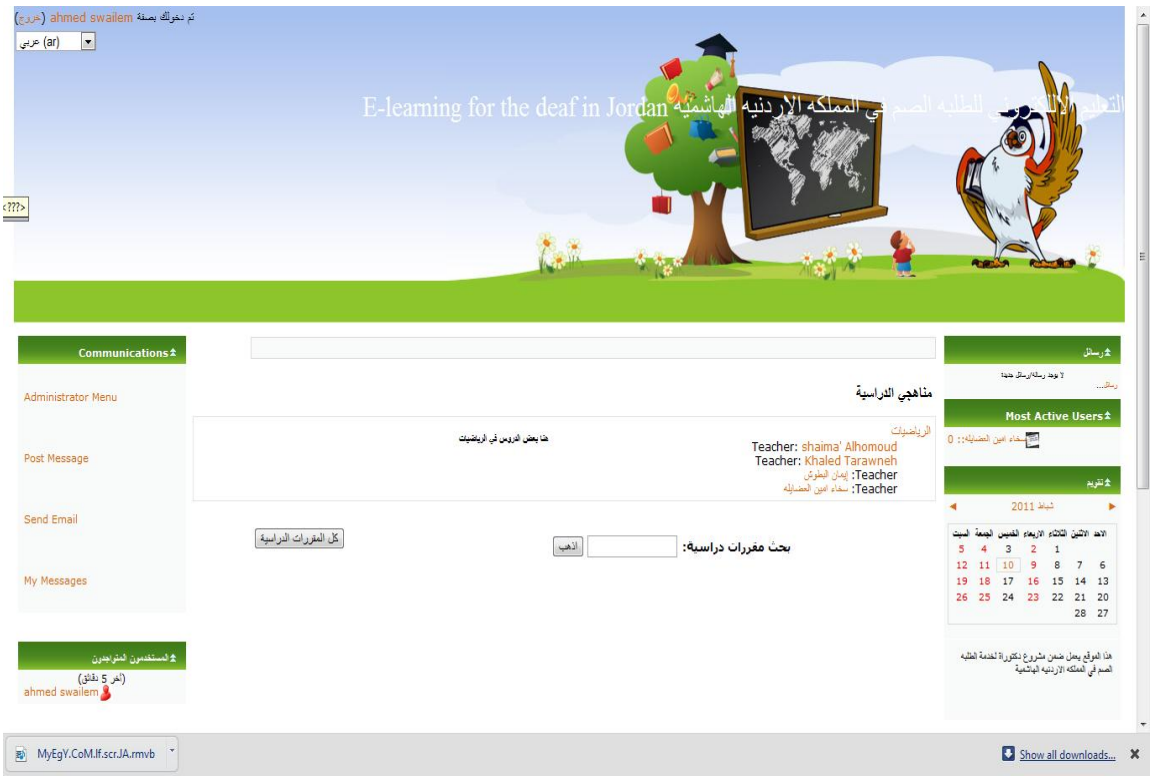


Figure 7. 9: Pupils/Students Main Page after Login

Figure 7. 10: Pupils/Students Course Page.

7.4.3. Course Resources and Activities

Activities are a very important aspect of the Moodle environment. They supplement the learning content making up the courses. The Course Page (see Figure 7.11) consists of three main columns. The columns on the far-left and far-right of the page contain blocks and panels, such as the participants block, activities available in the course (the activities block), a search tool block, an administration block, a courses block which shows the courses in which the user is participating and enrolled, the recent activity of the user, and many more (Cole & Foster, 2008). In the central column, the course content and activities are displayed. The learning materials are presented through a drop-down menu called "add a resource", which allows the user to view learning content in different forms and formats. Another drop-down menu, called "add an activity", allows the user to participate in different activities, such as assignments, assessments, chat, forums, Wikis, quizzes, Skype, SCORM/AICC and reports.

Figure 7. 11: A Topic-Formatted Course Framework Showing Available Resources and Activities

7.4.4. Course Format and Structure

According to Moodle (2010b), Cole & Foster (2008) and Rice (2006), Moodle provides different course formats forming the course layout. This includes different standard course formats, such as the weekly format, topics format, social format, LAMS course formats, SCORM format, timeline format, project format and the weekly CSS/no tables format. These formats are based on Moodle version 1.9.7 which was then upgraded to Moodle 1.9.8 during the research period. However, Wood (2009), Cole & Foster (2008)

and Rice (2006) mentioned specific formats such as LAMS, SCORM, the social format, topics format and weekly format-CSS/no tables. This is because each of these formats is useful in certain situations, as described below:

7.4.4.1. LAMS Format:

LAMS stands for "The Learning Activity Management System". According to Kraan (2003), this format was presented for the first time to the public by WebMCQ, "the online learning specialists" (http://www.webmcq.com.au/) and MELCOE, "Macquarie University's E-Learning Centre of Excellence" (http://www.melcoe.mq.edu.au/).

This format supports courses and learning materials developed using Flash-based authoring tools such as Authorware from Macromedia, now Adobe. In the Moodle environment, the LAMS format has been integrated to make use of Flash capabilities and tools to serve educational needs. This format uses the conventional lesson format in terms of sequencing the learning materials and providing the learners with "Acts", such as instant messaging services (Chat), structured debates (forums and blogs) and web polls in a specific sequence at specific times (Kraan, 2003). Cole & Foster (2008) indicate that LAMS is not popular and is not used much compared to other formats provided by Moodle, due to fact that it duplicates Moodle functionalities (Cole & Foster, 2008; Moodle, 2010b).

7.4.4.2. SCORM Format:

As mentioned in previous chapters, SCORM stands for "Sharable Content Object Reference Model". It is a package of learning content standards that can be used to produce a self-contained pack of learning content and uses JavaScript to communicate with Moodle about usage, scores and materials accessed by the users (Cole & Foster, 2008; Moodle, 2010b).

7.4.4.3. Social Format:

The social format uses the built in communication tools and functions within Moodle, such as forums, to deliver courses. Each course takes the form of a forum (Cole & Foster, 2008). According to Moodle (2010b), this type of format suits non-course use and meets the need for less formal courses.

7.4.4.4. Topics Format:

In this type of format, the course is structured into different topics. Within the Moodle environment, topics are grouped together into different sections together making up the whole course (Cole & Foster, 2008; Moodle, 2010b). This form of course design is most suitable when designing a course that is concept-oriented. In this research, after discussions between the researcher and the teachers/instructors of the deaf in the participating schools, this format was chosen to deliver topics in mathematics.

7.4.4.5. Weekly format and CSS/no tables:

In this type of format the course is based on a given time frame including start and end dates, with milestones on a weekly basis. During the course, the current week's topics are focused on including modifying the resources and activities for the whole course or for the each topic (section or week). The weekly format is considered very useful for a course based on timely objectives (Cole & Foster, 2008; Moodle, 2010b and Wood, 2009). It is important to note that CSS/no tables are no different from the weekly format other than the absence of tables within the layout of the course.

It is important to point out that, after choosing the course format based on the teachers' recommendations, the topics format was chosen for this research. The second step was adding/importing resources and activities. Both internal and external resources were used. Resources were linked from external websites that provided information on mathematical topics. Internal resources in the form of activities were provided to the learners. These were in the SCORM/AICC format.

The internal resources were developed using PowerPoint slides and then converted into a Flash format that conforms with SCORM/AICC standards using a third party software called "PPT2Flash Professional", which was developed by Wondershare (http://www.sameshow.com/powerpoint-to-flash-pro.html). These resources were based on the teachers' recommendations and some of them were developed by the teachers themselves. The researcher converted these resources into the SCORM/AICC format at a later stage and then imported them into Moodle. The external resources were imported from the School Arabia website (http://www.schoolarabia.net). The following figure

illustrates the course structure agreed with the teachers/instructors and used to deliver the learning content in Moodle.

Figure 7. 12: Course Structure used within the Moodle Environment

In Moodle environment, the administrator and any other users with administrative privileges can control access to the content and the content itself. Different content can be made available according to the ability of the user. This could be done either permanently or temporarily. There are both automatic and manual features regarding showing/hiding content (Wood, 2009), and such functionalities are used through the editing mode which enables the user to manage blocks, resources and activities.

According to Cole & Foster (2008), the editing mode allows the administrator to show/hide content, delete and move items (right, left, up and down). Such functions allow Moodle to be customised to meet the needs of deaf children, based on the recommendations of the teachers.

7.4.5. Pilot Testing the System

In this phase of the research, the researcher piloted Moodle in two stages. The first stage was performed on a personal computer (personal laptop) and the second online. In both stages, the functionalities and performance of Moodle were tested.

7.4.5.1. First stage

As mentioned previously, the first stage of piloting Moodle was performed on the researcher's personal laptop. The standard version of Moodle was downloaded from the website (http://download.moodle.org/). As Moodle is written in PHP scripting language, a database is required to store data. The Apache HTTP Server package is also required. The Moodle documents recommended using the MySQL database. Therefore, before installing Moodle, the researcher installed and tested a software package called

EasyPHP (http://www.easyphp.org/), which contains PHP, Apache HTTP Server and MySQL.

As with any other software, Moodle needs to be installed. However, before installing Moodle it is necessary to run EasyPHP, which controls the Apache HTTP server and the MySQL database. Before installing Moodle, there is a need to start the web server (EasyPHP). When installing Moodle, it performs a diagnosis to check the compatibility of the web server, including the PHP settings, the paths for the Moodle installation, such as the data directory, the Moodle directory and the web address. In addition, Moodle checks the database configuration, such as the type of database, the name of the database, users and passwords and the hosts of the database. Moreover, Moodle performs a check on the server and language packs.
At this stage, the researcher was aiming to familiarise himself with Moodle and test Moodle and its tools, such as course structure formats, administrative tools, communication and collaboration tools, etc.

The first testing stage included importing/exporting learning content (learning objects) in different course structure formats, such as LAMS and SCORM/AICC; the delivery of learning activities, such as tests based on assignments; and testing and familiarising myself with resource publishing, such as deploying and creating resources in different formats, such as electronic files, web links, online videos and SCORM/AICC packages). Moreover, the communication and collaboration tools, such as chat, messages, mail and forums were tested.

Finally, during this stage the researcher uploaded, imported and used some of the internal resources that were created for this study and external resources available on the internet.

7.4.5.2. Second stage

In the second stage, the teachers and pupils were involved in testing and piloting Moodle. In this stage, the main aim was to determine the main issues they faced when using Moodle. Before testing Moodle, the researcher created a Moodle account and registered it with Moodle. The Moodle version used in this pilot and the later research

was version 1.9.7. It was hosted by the website "Key to School" (http://www.keytoschool.com/).

In this stage, the users (testers) were four teachers and five pupils. They were introduced to Moodle through workshops and seminars. They were then asked to use the system for about four weeks. The participants were all from the Prince Hassan School for Special Needs.

The researcher's involvement in this stage was limited to guiding, observing and administering the teachers whilst they used Moodle. Sessions were also conducted on uploading resources and assisted the teachers in how to deal with the learning content and materials. During this phase, the host website was also tested by the researcher. Therefore, the main focus of this stage concerned the technical aspects of Moodle, the kind of learning content that should be used, the course structure and format and the sorts of activities that should be used or considered.
During this stage, the teachers provided some feedback regarding the use of Moodle, summarised below:

- The pupils/students should be able to register to the course directly, without the need for their instructor's approval, unless they need help with it.
- The resources added should be in the Arabic language.
- The resources added should be ordered in a pedagogical sequence similar to that used in the Jordanian mathematics textbook, as this would help them to meet the learning objectives.
- Learning content should be interactive and practice examples should be provided within each topic.
- Students' main page should be very simple and easy to access as should the course materials.
- Resources and learning content display area should take screen size into more consideration (it needed to be widened).

At the end of this pilot, a second questionnaire was piloted. The second semi-structured interview was used at the end of the evaluation phase which will be discussed in the next chapter.

The feedback and notes of the teachers were taken into consideration. The comments and feedback obtained revealed the following:

1. The questionnaire language and structure were clear and easy to follow.
2. In the semi-structured interview, some of the ellipses were not clear enough.
3. The average time needed to respond to the questionnaire was between ten and fifteen minutes.

Based on these comments, the questionnaire and the semi-structured interview note were reviewed and revised. Those terms and abbreviations that were unclear were modified to avoid any misinterpretations. Based on this, a redesigned questionnaire and semi-structured interview note were produced and implemented. Finally it is important to state that the feedbacks from the teachers were taken into the consideration during the implementation phase.

7.5. Summary

After determining the main requirements of the teachers (see Chapter 5) and selecting Moodle as the most appropriate LMS (Chapter 6), this chapter has illustrated the procedures taken to implement Moodle in the schools for the deaf in Jordan.

The implementation strategy was described, starting from approaching the MOE and the schools. The next, chapter contains descriptions of the procedures followed to recruit participants. A description of Moodle and the functionalities used in this research, including user type, course format and course resources and activities were also provided.

Finally, the Moodle was piloted to familiarise the researcher with its use and then used online hosting in order to allow some of the teachers and pupils to test it. The main focus of this pilot was on the technical aspects of Moodle, and its functionalities, such as user type, course format and content access. The feedback from the users in this initial pilot was taken into consideration in the implementation phase of the study, during which a full evaluation of the system was conducted.

CHAPTER 8

MOODLE EVALUATION

8.1. INTRODUCTION

Previously in this dissertation, Chapter 5 described the current status and use of e-learning and LMS, the deficiencies that prevent the use of such technology, and the main problems facing deaf pupils and their teachers when learning and teaching mathematics. Chapter 6 then explained the steps taken to evaluate various open source LMS. The evaluation was based on the key requirements developed from the comments obtained from the teachers/instructors of the deaf and other criteria. Chapter 7 explained the procedure taken to implement Moodle, starting from the theoretical framework, the approach made to the MOE and schools for the deaf in Jordan, the procedure used to recruit participants, a general description of Moodle and its tiers, user roles, the course resources and activities, course format and structure and the testing of Moodle.

After the successful implementation of the above steps, the Moodle evaluation phase began. The effectiveness of Moodle was assessed through a triangulation technique. This involved tracking the use of Moodle by the deaf pupils and their teachers (web-based observation), obtaining teachers' feedback on using Moodle, and a comparison of the achievements of deaf pupils in pre/post-tests. The results are presented in terms of the three types of evaluation. The methodological approach used in the evaluation is described in the following section.

8.2. METHODOLOGY

According to Horton (2001b), a variety of different techniques can be used to evaluate e-learning. Questionnaires, interviews and electronic tracking tools can all be used to evaluate the **responses** of the learners and users of the LMS. L**earning** can also be measured through tests and from the opinions of the teachers. Such tests can take the form of pre/post-tests or a final examination. The methods used in this research are based on the above ideas and are illustrated in Figure 8.1, starting with pre-testing the deaf pupils and ending with post-testing them. The teachers, meanwhile, were asked to

take part in semi-structured interviews and complete a questionnaire at the end of the process. The whole process was also observed though the built-in tracking tool.

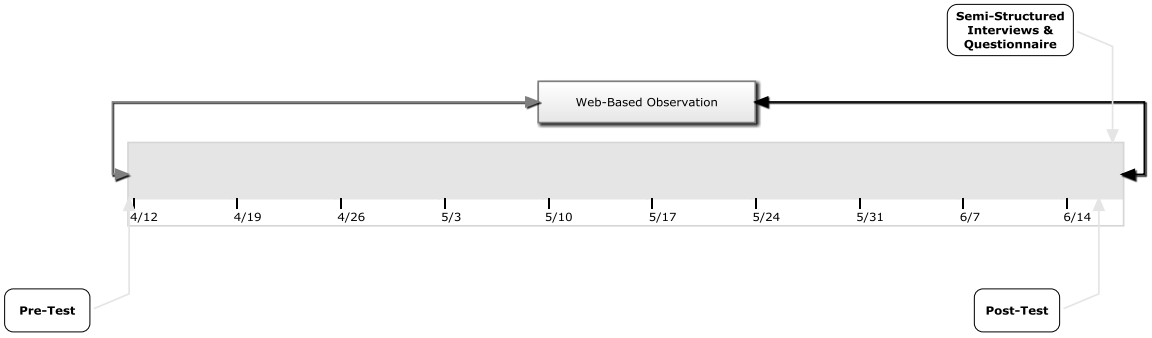


Figure 8. 1: Timeline for the implementation and evaluation of Moodle

Moodle evaluation involved three different stages: the preparation and implementation stage, running Moodle (the activation stage) and the termination stage.

8.2.1. Preparation stage

During this stage, all of the comments and recommendations made during the Moodle pilot testing were incorporated into the preparation and implementation of Moodle. The following procedures were taken during the preparation stage:

8.2.1.1. Preparing a Moodle tutorial

A simple tutorial was given to the teachers/instructors. The tutorial shows how to access and use Moodle and describes the functionalities and tools available. Some illustrations from the Moodle system were used as well. The tutorial was distributed in hard copy format; the language used in the tutorial was Arabic. The tutorial was based on Moodle's tutorial.

8.2.1.2. Preparing user accounts

The researcher and the teachers worked together to create pupil accounts for any pupils who were having problems creating their own accounts. This step was taken to ensure that the registration of both pupils and teachers was achieved.

8.2.1.3. Preparing the main course structure

After discussing the types of course format that Moodle offers with the teachers, the "topic format" was chosen, which puts the learning content

and materials into a topic-based structure (see previous chapter). The learning content and materials were categorised into two types:

- Internal, created by the teachers themselves with the help of the researcher;
- External, imported from educational websites offering free resources.

The topics were chosen based on the recommendations of the teachers and their relevance to the Jordanian curriculum textbook. This step ensured that there would be engagement from both the teachers and pupils. The topics covered primary level mathematics, including numbers (natural numbers, integers, and rational numbers), the four arithmetic operations (addition, subtraction, multiplication and division), fractions and fraction operations.

8.2.1.4. Uploading and linking learning content and materials to Moodle

The learning content and materials were uploaded into Moodle after converting it into SCORM/AICC standard compliance. Other learning content was imported and linked from external sources.

8.2.1.5. Teachers'/Instructors' session

As mentioned in Chapter 6, training sessions for the teachers were offered so that they could learn how to use Moodle and then introduce it to deaf pupils. In the workshops, the teachers/instructors were introduced to the research aims and objectives, given a general introduction about Moodle and the whole process of evaluation. They were also informed that the researcher would be monitoring (web-based observation) how they and their deaf pupils used the system (their activities). Information on the procedure that should be used for the pre- and post-tests was given, such as the fact that the tests should be unified in order to guarantee a fair comparison of the test results before and after using Moodle.

8.2.1.6. Informing deaf pupils and their parents/guardians

Teachers/instructors informed deaf pupils about Moodle and told them that they would only have to use it if they wanted to and if they had permission from the parents/guardians.

8.2.2. Activation stage

During this stage, the teachers/instructors and their deaf pupils used and interacted with Moodle. The following steps were taken:

8.2.2.1. Conducting the pre-test

The deaf pupils underwent a pre-test to assess their level of achievement before using Moodle.

8.2.2.2. Accessing Moodle

The teachers/instructors and their deaf pupils started to access the learning content and materials and used Moodle tools such as messages (internal mail), instant messages (chat), Dimdim (videoconferencing and whiteboards) and other tools. The teachers and pupils used Moodle for nine weeks.

8.2.2.3. Accessing times

The access time was categorised as either on-campus or off-campus. On-campus access was considered to start at 8:00am and end at 2:59pm, mainly during school time. Off-campus access started at 3:00pm and ended the following day at 7:59am, mainly occurring at home. The tracking system in Moodle (web-based observation) facilitated this task and allowed for 24-hour monitoring.

8.2.2.4. Accessing mode

Based on the above and the recommendations of the teachers, the two e-learning classifications described by Negash & Wilcox (2008) (see Chapter 3) were employed. These classifications are used to describe the mode of accessing Moodle and are known as blended/hybrid synchronous or e-

learning with presence and with communication and asynchronous learning.

8.2.3. Termination Stage

During this stage, the evaluation process was completed and included the following:

8.2.3.1. Questionnaires

The questionnaires were distributed to the teachers during the preparation stage and they were asked to complete and return them at the end of the activation stage. The questionnaires were scanned and collected by email.

8.2.3.2. Post-test

The deaf pupils took a post-test to assess their level of achievements after using Moodle.

8.2.3.3. Semi-structured interviews

These were conducted over the phone with six teachers. The questions were straightforward and the interviews lasted no more than 10-15 minutes each.

8.2.3.4. Analysing the results from the tracking system

The activities of the teachers and their deaf pupils when using Moodle were analysed.

8.2.3.5. Data treatment

The data were gathered and digitised in SPSS and Excel. The data were then analysed using different techniques based on how they were sourced. The results of the pre-test and the post-test were compared. The data generated by the Moodle tracking system (web-based observation) were analysed.

8.2.3.6. Deleting the data

All of the data obtained were deleted and destroyed. All of the accounts were deleted from Moodle.

8.3. RESULTS

In this section, the results of the evaluation of using Moodle are presented. The results were obtained (as described above) from tracking the activities of the Moodle users (web-based observation), questionnaires, semi-structured interviews and pre/post-tests.

8.3.1. Interviews Supplemented With Web-Based Observation

Semi-structured interviews were conducted with the teachers after they had used Moodle. The aim was to find out the teachers' perceptions of using Moodle and gain deeper insight into the major advantages and disadvantages of using e-learning.

All of the interviews were conversational in style allowing teachers to express their own personal views on using Moodle and state which tools and facilities in their opinion helped to improve the deaf pupils' academic achievements in mathematics. All the interviews, at this stage, were carried out by telephone.

In this part a descriptive statistical analysis presented on the use of Moodle by teachers and their deaf pupils. This includes the general use and the activity-based, daily and weekly, use of Moodle. (The research period started on 12th April, 2010 and finished on the 12th June, 2010). The total number of days over which the teachers' and pupils' used Moodle was assessed as 62, or approximately nine weeks.

Figures 8.2 and 8.3 illustrate the distribution of the daily and weekly use by teachers and their pupils. It should be noted that high values at the beginning are due to the registering of the deaf students. The teacher represents 16.67% of the sample and the deaf pupils represent 83.33%. The explanation for the high use at the beginning of using Moodle was because of the registration process done by deaf pupils and their teachers. It also included, the training sessions conducted by the researcher to train the teachers on using the Moodle. However, after April 21st 2010, was a normal distribution.

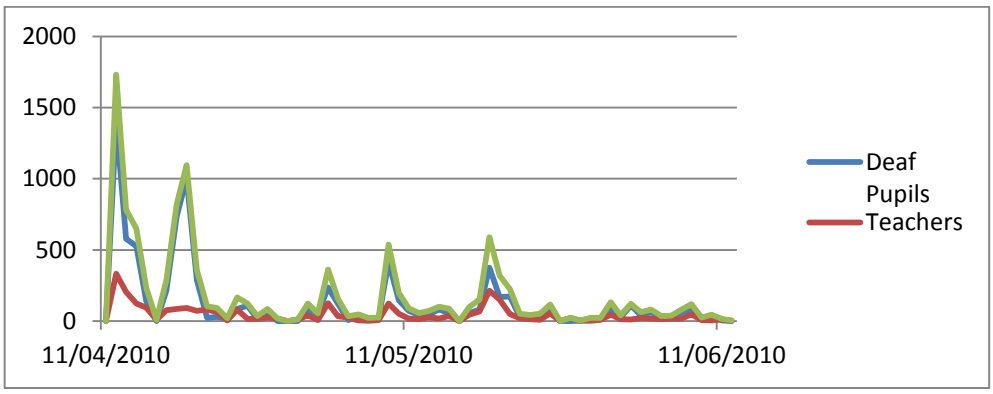
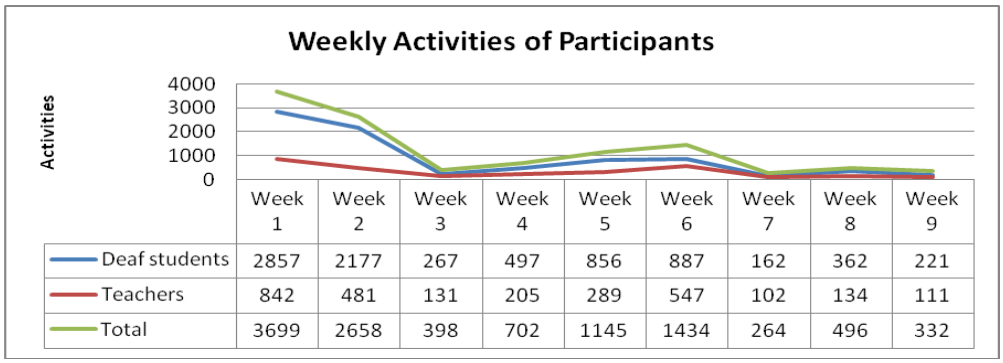


Figure 8. 2: Daily use of Moodle by the teachers and their deaf pupils.



	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9
Deaf students	2857	2177	267	497	856	887	162	362	221
Teachers	842	481	131	205	289	547	102	134	111
Total	3699	2658	398	702	1145	1434	264	496	332

Figure 8. 3: Weekly use of Moodle by the teachers and their deaf pupils.

After using Moodle, can you tell me your perceptions toward Moodle and e-learning in terms of the following?

8.3.1.1. A change in the understanding e-learning (redefining learning)

All six interviewed teachers agreed that participating in this research was a new experience that had broadened their view of e-learning. Previously, the concept of e-learning for them represented no more than a set of PowerPoint slides and demonstrations on projectors, and they were in favour of using traditional, conventional teaching methods (lecturing). This part of the answer indicates that using Moodle during the trial period had overcome their previous opinion that only conventional teaching methods should be used.

8.3.1.2. Effectiveness of the workshops and tutorial

One teacher indicated that she had to go back to the tutorial in order to help her pupils to use Moodle at the start of the trial. This indicates that both the training

workshops conducted with the teachers and the tutorials were helpful and served their purpose well.

8.3.1.3. Monitoring students

Moodle gave the teachers the ability to track students' progress in specific topics. This helped them to track each pupil and to focus on students needing more attention.

This response indicates that Moodle addressed the issue raised by the teachers (described in Chapter 5) that they needed a mechanism to monitor the progress of their pupils. The teachers had indicated that they did not have a mechanism to know whether the students had grasped the information they had been taught before using Moodle. However, after sing Moodle and through the tracking system they managed to monitor their pupils' activity and topics which have been covered and which had been missed out.

8.3.1.4. Access Modes

Using Moodle has given both the deaf pupils and their teachers 24-hour/7 days a week (anytime, anywhere) access to the learning content and materials. The teachers noted that the deaf pupils were accessing the learning content outside of school time. Before this, they were unsure whether the deaf pupils were learning (or studying) when at home. Through using Moodle, the teachers reported that they could fully adapt to the needs of all the deaf students by monitoring the activities of deaf pupils and responding to their needs more effectively.

This demonstrates that Moodle has solved some of the issues facing deaf pupils in terms of accessibility and collaboration, which were identified by the teachers as described in Chapter 5. The deaf pupils have been learning and studying at home through the new medium and at their own pace. Moreover, the use of Moodle has solved some of the issues over access to the support of teachers and colleagues.

The system tracking tool provided statistics on the modes of access (blended hybrid synchronous vs. asynchronous) used by the teachers and pupils. The

difference in the teacher's use of blended-hybrid synchronous vs. asynchronous modes is due to the fact that the teachers would have had to deal with each pupil using the asynchronous mode of access. The following figures show that Moodle was accessed off-campus more than on-campus:

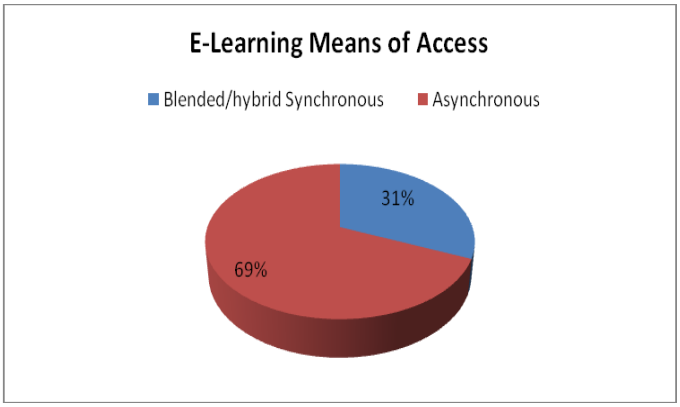


Figure 8. 4: Moodle usage based on means of access

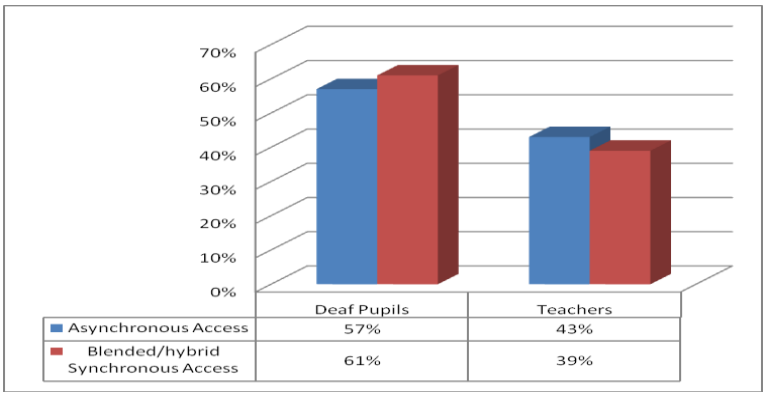


Figure 8. 5: Moodle usage based on user type and access mode

8.3.1.5. The Use of Moodle

The teachers indicated that they felt that the deaf pupils enjoyed using Moodle. Teachers of more than one subject indicated that the deaf pupils were more excited when using Moodle than they had previously been when learning mathematics without Moodle or when they were learning other subjects, such as science or Arabic.

This shows that Moodle overcame the teachers' concerns that they could not hold their deaf pupils attention. This can also be seen from the tracking system,

showing that 74.5% of the total usage of Moodle was by the deaf pupils as opposed to the teachers and is illustrated by the following figure:

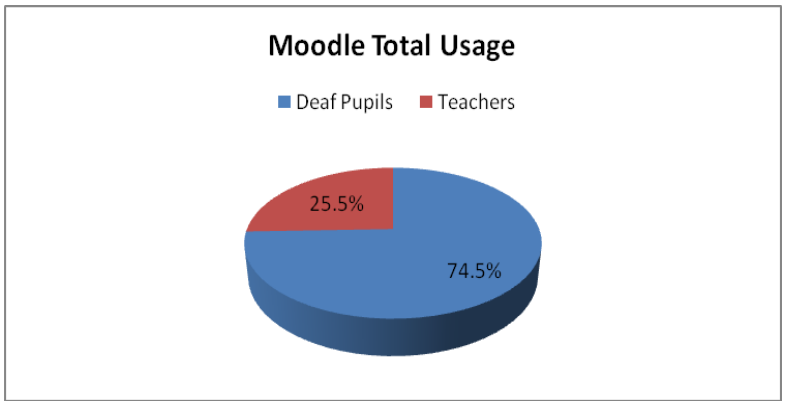


Figure 8. 6: Moodle usage based on user type

8.3.1.6. Navigation

The teachers indicated that the learning content was structured simply and was easy to access and navigate. They also found the learning content and materials to be structured and sequenced according to a Jordanian textbook.

Moodle presents the learning content and materials in a logical way. The following figures illustrate two of the means of navigating in Moodle: the navigation bar (Figure 8.6) and the navigation panel or block (Figure 8.6)

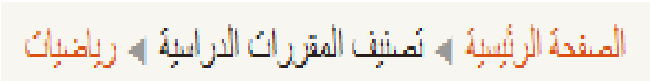


Figure 8. 7: Navigation bar

Figure 8. 8: Navigation block

8.3.1.7. Interactive Content

According to the teachers, deaf pupils were able to access the learning content and engaged with the interactive content. The interactive content helped to hold the deaf pupils' attention. The teachers also indicated that the way in which the learning content was presented and structured reinforced their teaching by providing more resources in an interactive way. As was mentioned above, the deaf pupils were more excited about using Moodle than they were in other classes or when learning mathematics without Moodle.

Before using Moodle and e-learning, the deaf pupils had found it hard to comprehend the teaching and explanation of specific topics. One of the interviewees indicated that "*the children never paid full attention in mathematics class as they were confused and unable to comprehend some of what I was trying to teach*". However, the interactive content engaged the deaf pupils in the learning process. The following figures represent the interactive content.

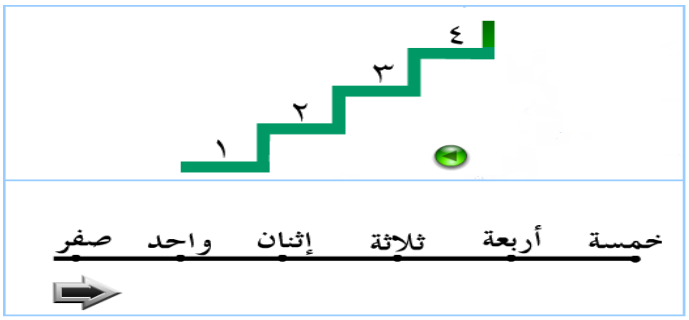


Figure 8. 9: Before pressing the green button (before interaction)

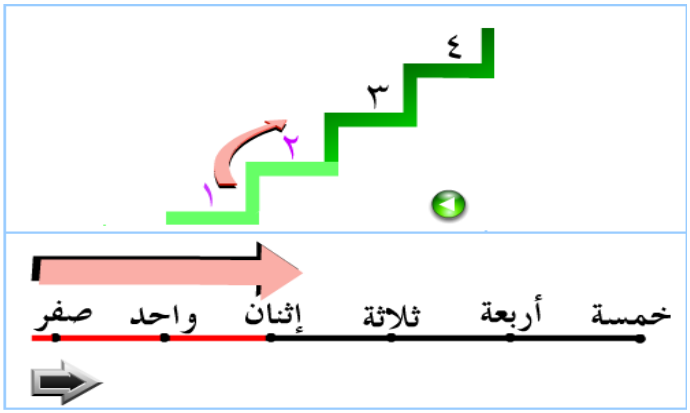


Figure 8. 10: After pressing the green button (after interaction)

8.3.1.8. Accessing and sharing the learning content and resources

The teachers indicated that they were happy with the simplicity of accessing the learning content. Moreover, they were happy with the fact that all the learning content was shared between the participating schools, which were considered to be an attempt towards providing equality of teaching between schools having differing levels of resources or numbers of skilled teachers. Moodle allowed the teachers to expand and share resources amongst themselves and supported interaction between them. Figure 8.11 shows the access to learning content as a percentage of total access, whilst figure 8.12 shows the distribution of access to learning content by mode and user type.

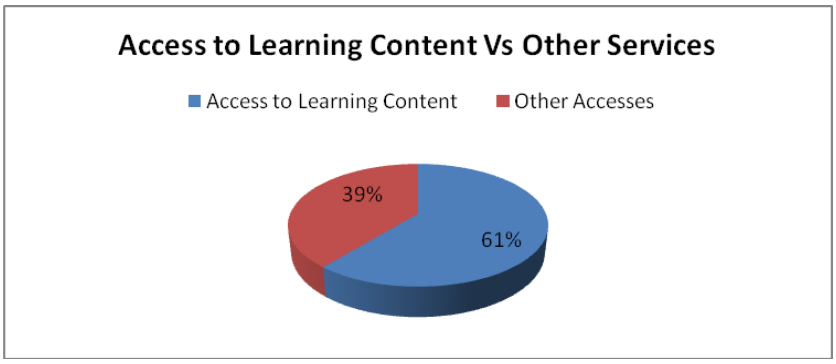


Figure 8. 11: Access to learning content vs. other access.

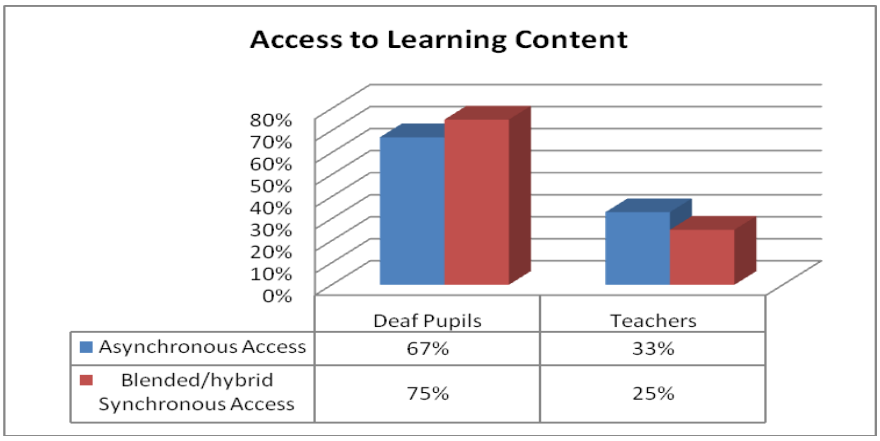


Figure 8. 12: Access to learning content categorised by user type and mode

8.3.1.9. Access to activities (communication and collaboration tools)

According to Dawley (2007), various tools are used to deliver effective online learning, such as instant messages (chat), electronic presentation tools, and e-mail. These tools promote communication and collaboration among the learners, leading to an interactive learning experience ultimately resulting in successful learning.

The teachers indicated that they and their pupils used activities such as forums, chat, messages, dimdim and blogs. They said that such tools enabled them to interact with other teachers as well as their deaf pupils. The teachers stated that the use of such tools has helped enormously by providing different ways of communication and collaboration. This is an indication that using Moodle has activated the students' role in the classroom from being passive to active, which will speed up the learning process.

The use of such tools has improved the teachers' interaction with the deaf pupils. The tools have also been used by the teachers to communicate with each other, mainly when off-campus, to clarify aspects of the various topics being taught and share information with one another. A new way of communicating, which had rarely been used previously, either inside or outside of the classroom was evident. Moreover, using Moodle has promoted multi-way communication allowing the deaf pupil to be both receptor and transmitter at the same time.

8.3.1.10. General Use of Activities

When analysing the teachers' and pupils' usage activities, it can be seen that the two main means of communication used during the trial were instant messages (chat) and internal messages (internal e-mail). On average teachers carried out 14.8% of all activities, and deaf pupils 83.4%. Teachers and their pupils used the activities provided in Moodle as the following:

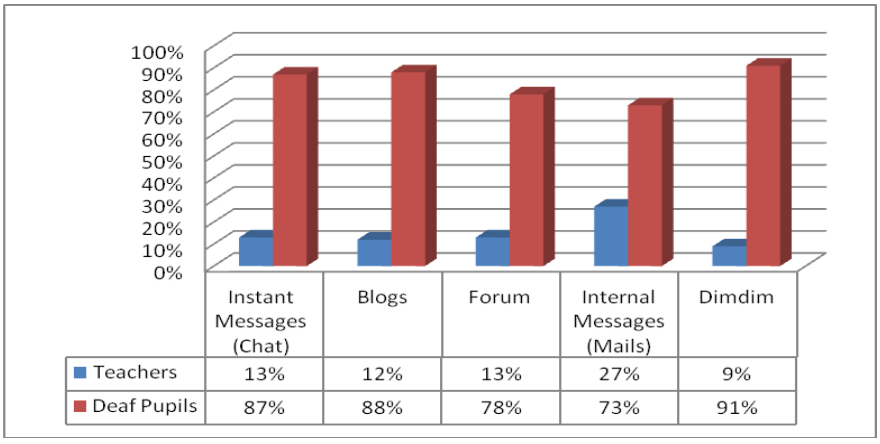


Figure 8. 13: General usage of activities.

The following figure illustrates the distribution of usage by activity for teachers and pupils combined:

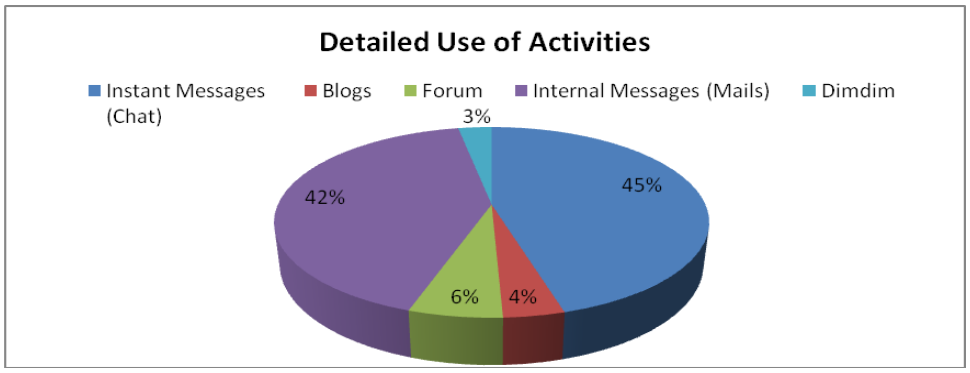


Figure 8. 14: Distribution of use by activity for teachers and deaf pupils combined.

The distribution of the teachers' and the pupils' usage respectively, by activity is illustrated below:

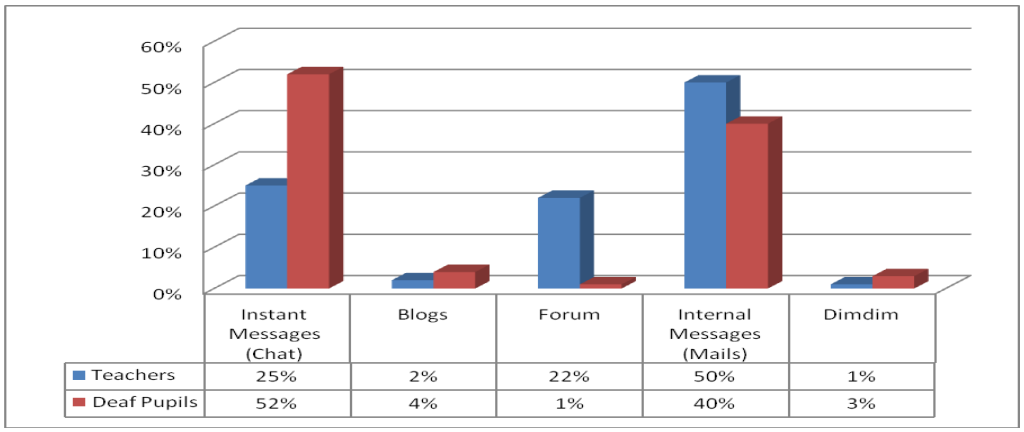


Figure 8. 15: Teachers' and deaf pupils' usage of different activities.

8.3.1.11. Use of Instant Messages (Chat)

The tracking system revealed that 13% of the total use of instant messages was by the teachers and 87% by pupils. In the asynchronous mode of access, 19% of the use was by the teachers and 81% by pupils, whilst in the blended/hybrid synchronous mode of access, 10% of the use was by the teachers and 90% by pupils. Indeed, instant messages were the tool most used by the deaf pupils, as shown in Figure 8.15. The following figure illustrates how this tool would be used in the blended/hybrid synchronous mode of access.

Figure 8. 16: Chat activity report and the users of the tool, along with start and end times.

8.3.1.12. Use of Blogs

The tracking system revealed that 12% of the use of this tool was by the teachers and 88% by their pupils. In the asynchronous mode of access, 8% of the use was by the teachers and 92% by their pupils, while in the blended/hybrid synchronous mode of access, 24% of the use was by the teachers and 76% by their pupils. Blogs and Dimdim were the tools that were least used by the teachers, as shown in Figure 8.15.

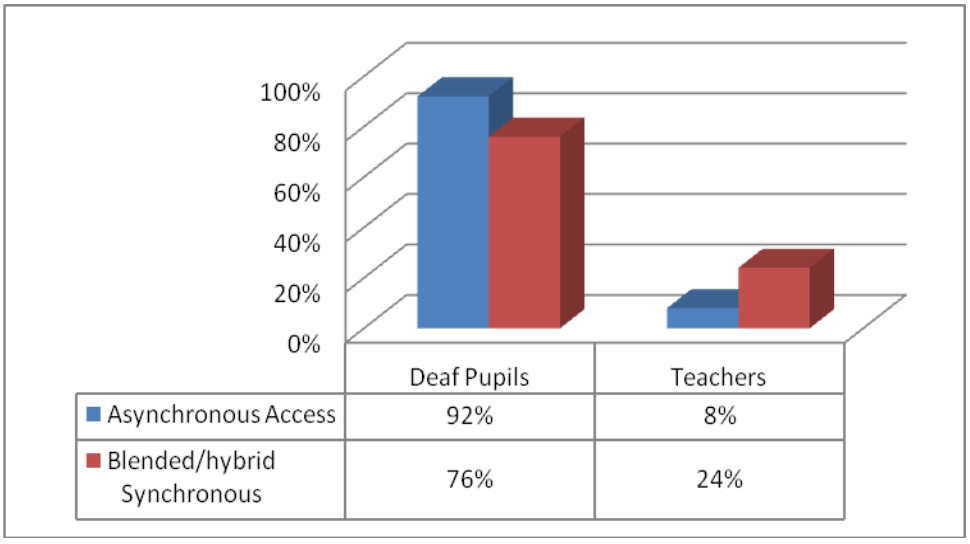


Figure 8. 17: Distribution of the use of blogs by the teachers and deaf pupils for each access mode.

8.3.1.13. Use of Dimdim

Dimdim is an open source web meeting tool that can be used to show and share presentations, applications and desktops in real-time to other people who are online. Dimdim offers chat, whiteboard and webcam. It does not require any special arrangements other than the installation of the latest version of Adobe Flash player and a plugin on the computer. It can run on any computer and was integrated into Moodle for this research.

According to the teachers, Dimdim ran on most of the computers used in this study but not on some others. The researcher believes that this is because it will not run if there is no Flash player installed on the computer. Moreover, Dimdim requires a plugin to be installed which may not have been installed on these computers as teachers instructed. Due the nature of Dimdim, access occurs in the synchronous mode only. As illustrated in Figure 8.13, 9% of the use of this tool was by the teachers and 91% by their deaf pupils. Unfortunately, from March 15, 2011 users will no longer be able to use free accounts as Dimdim has been acquired by salesforce.com which will offer the Dimdim service for a fee. The following figure is a snapshot from the Dimdim interface.

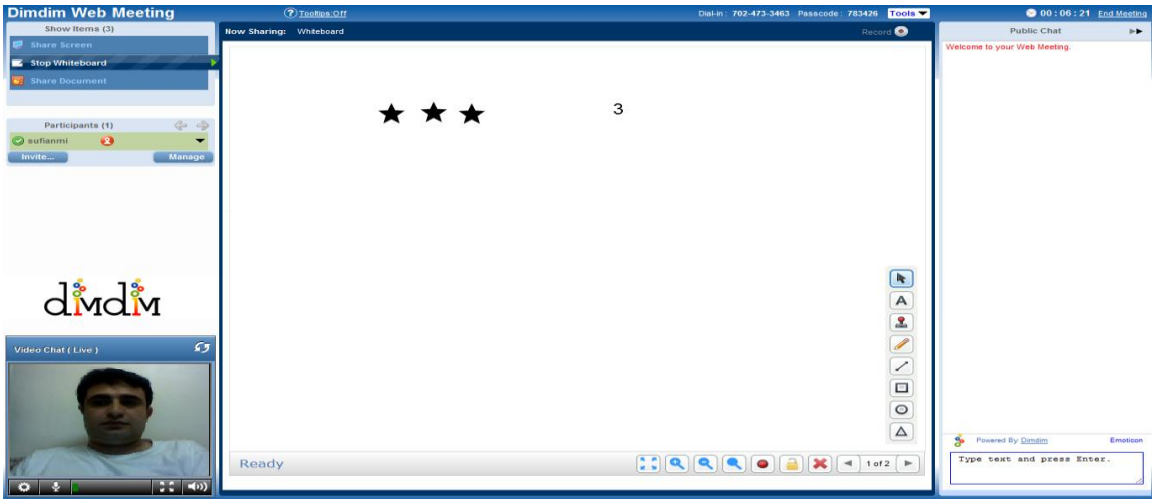


Figure 8. 18: Dimdim user interface.

8.3.1.14. Use of Internal Messages

The teachers indicated that the internal messages were their preferred medium of communication. They used it to communicate with each other and with their deaf pupils. The tracking system indicated extensive use internal messages by the teachers

and pupils (it represented 42% of all usage across both user types and 50% of the teachers' total usage, as shown in Figure 8.15). The following figure shows the use of internal messages in each access mode.

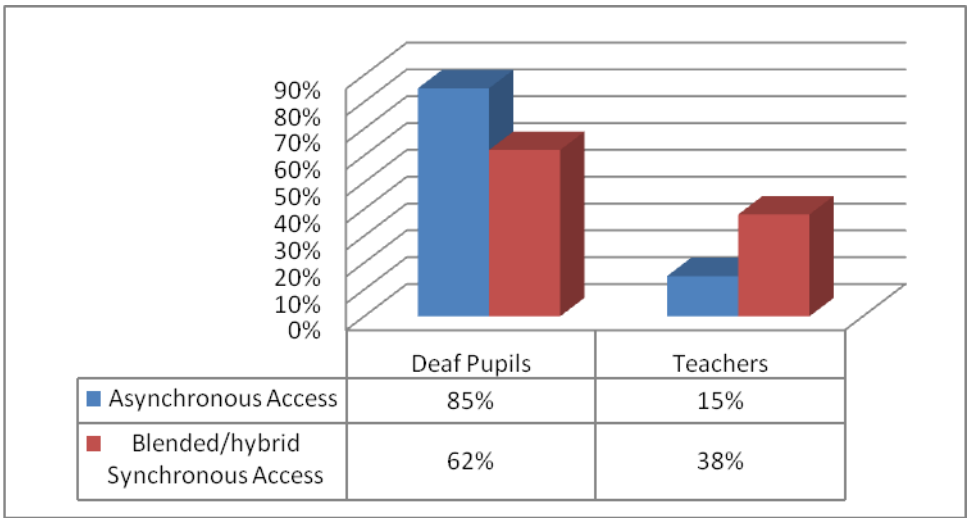


Figure 8. 19: Distribution of the use of internal messages by the teachers and their deaf pupils, for each access mode.

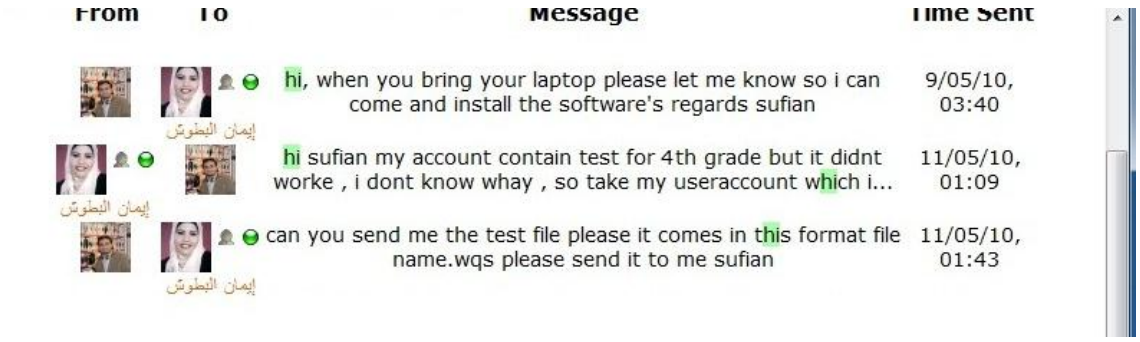


Figure 8. 20: Use of internal messages between administrator and teachers.

8.3.1.15. Use of Forums

According to the teachers, forums were little used by their pupils, as they preferred to receive faster responses from their teachers and other pupils. The idea of this tool is that as the user logs into Moodle, if they have new messages, they will be informed by the system. But Moodle appears to have failed to inform the users about new topics or responses to their enquiries on the forum. Indeed, the forum was the tool least used by the deaf pupils, as Figure 8.15 shows. The following figure shows the distribution of the use of the forum by user type, for each access mode.

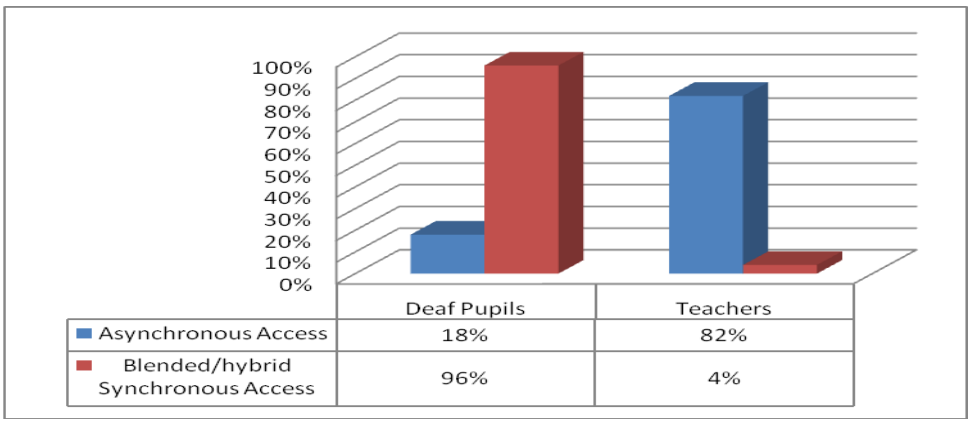


Figure 8. 21: Distribution of the use of the forum by user type for each access mode.

The following figures illustrate the general use of activities, logins and learning content in Moodle by the teachers and their deaf pupils.

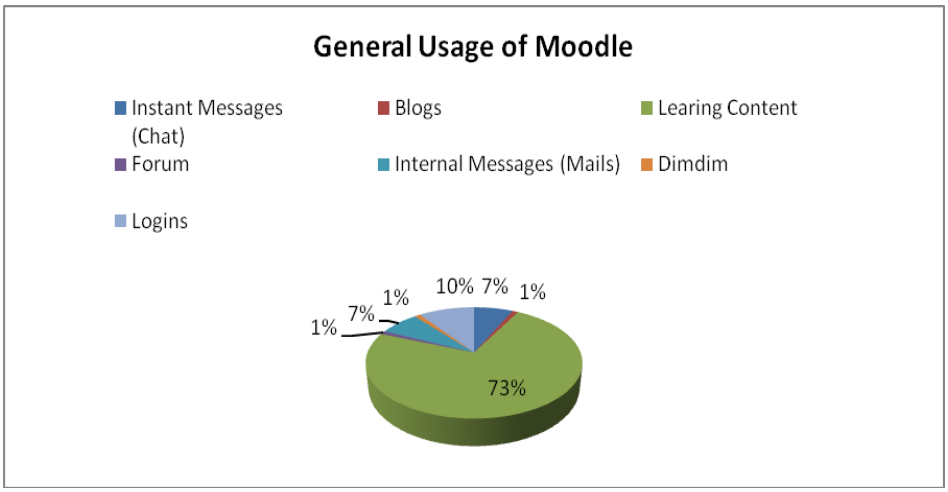


Figure 8. 22: General use of activities, logins and learning content in Moodle.

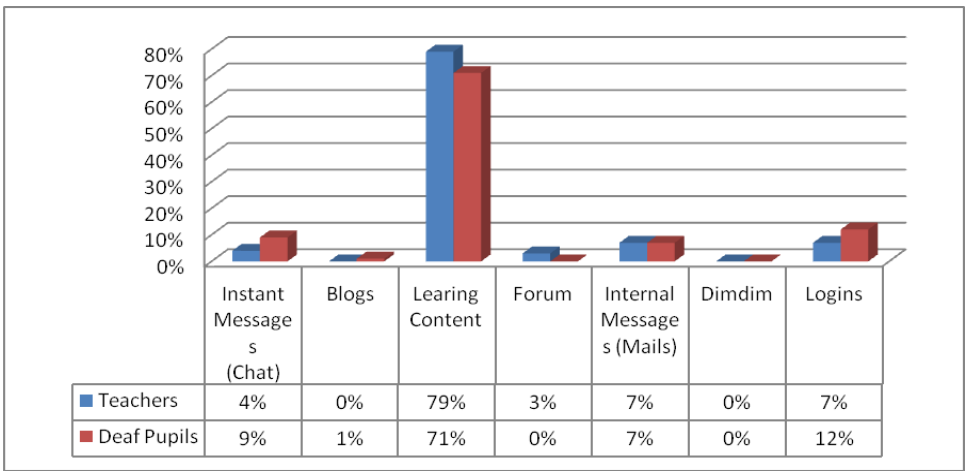


Figure 8. 23: Distribution of the general use of activities, logins and learning content in Moodle by teachers and their pupils.

8.3.2. Pre/Post Test

According to Horton (2001b), evaluating and testing e-learning includes "knowledge evaluation", which is measuring what the student has learned. Moreover, Kirkpatrick & Kirkpatrick (2006) indicate that the reason for such evaluation is to improve future learning programs. In this research, pre and post-tests were conducted to offer a more careful evaluation of the impact of Moodle on the deaf pupils' performance.

To begin with, achievement tests were developed to assess the deaf pupils' achievements prior to and after the experiment. Five mathematics teachers helped to design the tests, the five teachers have prepared both the pre-test and the post-test. It was then checked for validity by a panel of mathematicians, educational and deaf studies experts. The panel comprised an experienced university professor of mathematics, five mathematics teachers of the deaf, an experienced university professor of statistical analysis and an experienced university professor of special needs.

The panel was asked to validate the content of both tests in terms of relevance, clarity and appropriateness. All suggestion and modifications were taken into consideration in the final draft of the tests. The panel's agreement on the two tests was 84% and 86%, respectively, indicating that they are valid items. The correlation coefficient was 0.92% on Kronbach (α) was considered to be appropriate for conducting this test. The deaf pupils were asked to take the pre-test that was developed to assess their competency in mathematics.

The effectiveness of the e-learning environment was also judged by comparing the previous year's deaf pupils' scores in these tests with the current year's deaf pupils' scores in the pre/post-tests. In this part of the analysis, the researcher used one way ANOVA comparisons. The comparison was made between the pre-test results, the post-test results (after using Moodle), and last year's results (1^{st}& 2^{nd} exams).

In the test, the fixed factors were the pre-test, the post-test and the previous year's results (scores). The scores are the dependent variable. All scores were anonymised. As mentioned previously, this test was performed using SPSS software. The main reason for doing this test was to answer the following question:

Is there a statically significant difference between the scores obtained last year and this year by the deaf pupils?

8.3.2.1. The Between-Group Design

The following tables show the between-group analysis:

Table 8. 1: Groups Descriptive Statistics

Year		N	Mean	Std. Deviation
Scores (results)	Current pre-test	75	11.76	3.031
	Current post-test	75	13.91	2.417
	Previous year 1st exam	58	11.55	3.045
	Previous year 2nd exam	58	11.84	2.574

Table 8. 2: One-way ANOVA for results before using Moodle.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.665	2	1.332	.158	.854
Within Groups	1585.628	188	8.434		
Total	1588.293	190			

From the above table it is noticeable that the sig. value (p-value) is greater than 0.05, and hence it can be concluded that there are no statistical differences at $\alpha \leq 0.05$ between the results before using Moodle across the different tests, i.e., the current year's results represented by the pre-test and last year's results in the 1st and 2nd exams. However, the results obtained after using Moodle are shown in the following table:

Table 8. 3: One-way ANOVA for all results.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	259.574	3	86.525	11.234	.000
Within Groups	2017.975	262	7.702		
Total	2277.549	265			

From the above table it is noticeable that the sig. value (P-value) is less than 0.05, and hence there are statistical differences at $\alpha \leq 0.05$ between the current year's results, represented by the pre-test (1st) and the post-test (2nd), and last year's results in the 1st and 2nd exams.

To determine which group had the highest results, post-hoc tests (Scheffe) of post comparisons were performed, resulting in the following table:

Table 8. 4: Scheffe test (Multiple Comparisons).

(I) Year	(J) Year	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Current Year (pre-test)	Previous Year (1st exam)	.208	.485	.980	-1.16	1.57
	Current Year (post-test)	-2.147*	.453	.000	-3.42	-.87
	Previous Year (2nd exam)	-.085	.485	.999	-1.45	1.28
Previous Year (1st exam)	Current Year (pre-test)	-.208	.485	.980	-1.57	1.16
	Current Year (post-test)	-2.355*	.485	.000	-3.72	-.99
	Previous Year (2nd exam)	-.293	.515	.955	-1.74	1.16
Current Year (post-test)	Current Year (pre-test)	2.147*	.453	.000	.87	3.42
	Previous Year (1st exam)	2.355*	.485	.000	.99	3.72
	Previous Year (2nd exam)	2.062*	.485	.001	.70	3.43
Previous Year (2nd exam)	Current Year (pre-test)	.085	.485	.999	-1.28	1.45
	Previous Year (1st exam)	.293	.515	.955	-1.16	1.74
	Current Year (post-test)	-2.062*	.485	.001	-3.43	-.70

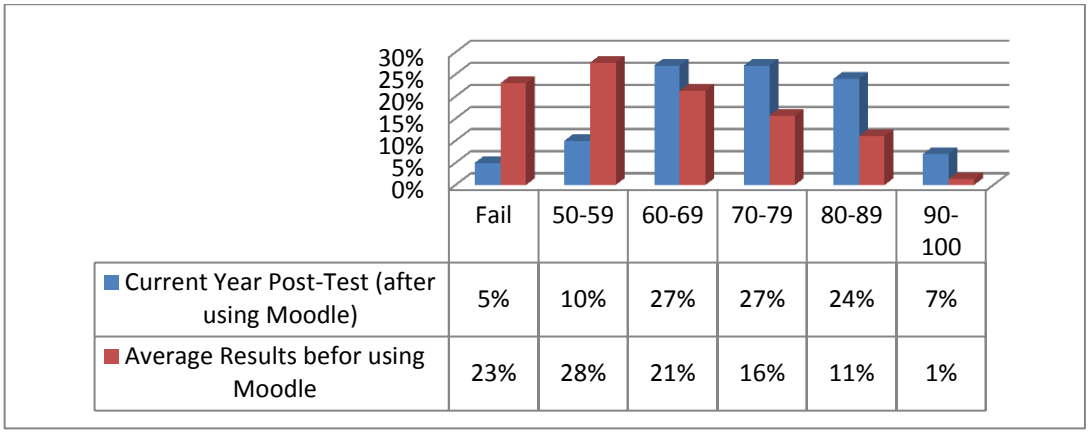
8.3.2.2. The Within-Group Design

In order to conduct this test, an independent t-test was used to check whether there was statistical significance between the pre/post-test results.

Table 8. 5: Pre/Post-Test Groups Descriptive Statistics.

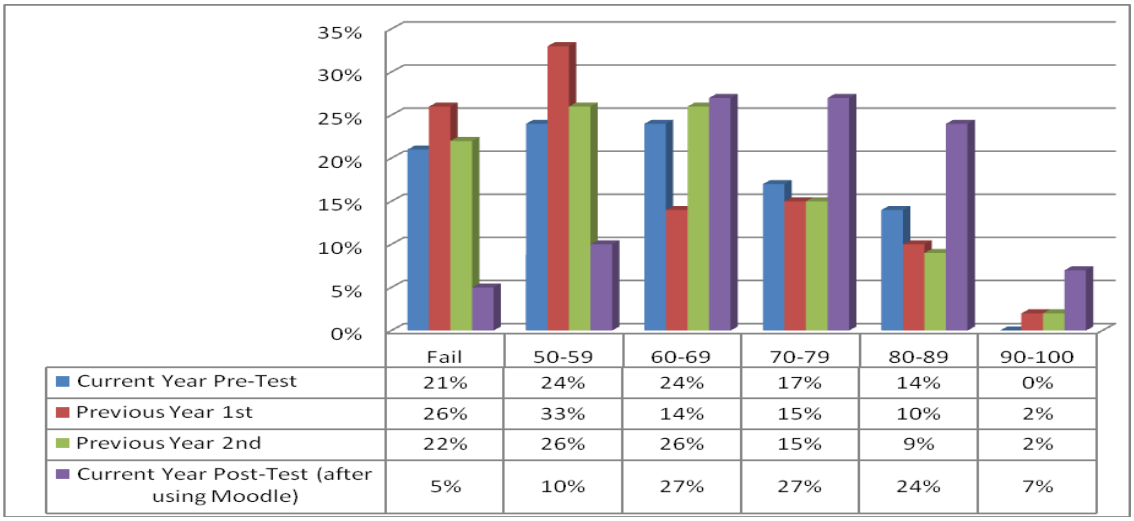
Year		N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Scores (results)	Pre-test	75	11.76	3.031	-4.796	148	.000
	Post-test	75	13.91	2.417			

8.3.2.3. Comparison of percentages between groups



	Fail	50-59	60-69	70-79	80-89	90-100
Current Year Post-Test (after using Moodle)	5%	10%	27%	27%	24%	7%
Average Results befor using Moodle	23%	28%	21%	16%	11%	1%

Figure 8. 24: Results of the Post-Test, the Average of the Other Assessments and the Range of Scores.



	Fail	50-59	60-69	70-79	80-89	90-100
Current Year Pre-Test	21%	24%	24%	17%	14%	0%
Previous Year 1st	26%	33%	14%	15%	10%	2%
Previous Year 2nd	22%	26%	26%	15%	9%	2%
Current Year Post-Test (after using Moodle)	5%	10%	27%	27%	24%	7%

Figure 8. 25: Results of the Assessment Used in this Research and the Range of Scores

8.3.2.4. Discussion

Based on the results, there was significant effect of using e-learning through Moodle compared to the conventional teaching methods used so far to teach deaf pupils in Jordan. This may be due to the fact that e-learning tended to create an attractive learning environment for both the deaf pupils and their teachers. Compared to conventional teaching methods, during the blended/hybrid synchronous mode almost all of the deaf pupils participated actively and showed enthusiasm towards e-learning, the interactive content and the activities.

Moodle attracted the deaf pupils' attention. Moreover, the interactive content motivated them to learn by providing immediate feedback through visualisations. It also enabled them to participate in different learning activities and improved their personal achievements, steering their learning in a structured way.

Using Moodle rather than conventional methods gave deaf pupils the basic knowledge, skills and abilities that are needed in the e-learning environment. This has resulted in several outcomes: the deaf pupils gained higher scores after using Moodle. The mean score before using Moodle was 11.76 and this increased to 13.91 after using Moodle. This can be seen in Figures 8.23 and 8.24 which present the differences in the distributions of scores between the tests. Specifically, the following improvements have been achieved:

- ***Scores in the 90-100% range:*** for the within-group design, the percentage of pupils in this category increased by 7%. For the between-group design it increased by 5%. Therefore, on average, the increase was 6%.
- ***Scores in the 80-89% range:*** for the within-group design, the percentage of pupils in this category increased by 10%. For the between-group design it increased by 13%. Therefore, on average, the increase was 11.5%.
- ***Scores in the 70-79% range:*** for the within-group design, the percentage of pupils in this category increased by 10%. For the between-group design it increased by 11%. Therefore, on average, the increase was 10.5%.
- ***Scores in the 60-69% range:*** for the within-group design, the percentage of pupils in this category increased by 5%. For the between-group design it increased by 7%. Therefore, on average, the increase was 6%.
- ***Scores in the 50-59% range:*** for the within-group design, the percentage of pupils in this category decreased by 14%. For the between-group design it decreased by 18%. Therefore, on average, the decrease was 16%.
- ***Failure:*** for the within-group design, the percentage of pupils in this category decreased by 16%. For the between-group design it decreased by 18%. Therefore, on average, the decrease was 17%.

This shows that the percentage of pupils falling into the categories of 50-59% or failure reduced. This demonstrates that using Moodle increased the deaf pupils' achievements

and moved them into the higher (60-69%) and (70-79%) categories. Looking to above results means that the use of e-learning and LMS has increased the academic achievements of the deaf pupils in Jordan and pushed deaf pupils from failure category into pass one. This is shown clearly through the 18% decrement in between groups and 16% within-group.

The category 50-59% range has affected by the increment happened into the failure category and increased. The average increment as stated above is 16%. In the 60-69% categories, the increment has been very little compared to the lower two categories. However, this is justified because of the high percentage before the intervention and using Moodle. The category 60-69% range has affected slightly by the increment happened into the 50-59% category and increased by 6% on average. The category 70-79% and 80-89% ranges have been affected by the increment happened into the 60-69% and 70-79% categories and increased by 10-11.5% on average. Finally, the category 90-100% has increased by 6% on average which is been affected by the increment happened in the 80-89% category. As a conclusion Moodle has a slight effect in improving the deaf pupils' achievements in these categories (higher categories) but noticeable effect on the failure and 50-59% categories and has moved deaf pupils' achievements to pass category.

8.3.3. Questionnaire

In this section, the outcome of the teachers' responses toward the readiness, usability and user satisfaction of Moodle, its learning content and materials, and collaboration and communication tools will be presented. Ten teachers responded to the questionnaire, which was based on evaluation questions proposed by Khan (2005) and Al-Khalifa (2010). Al-Khalifa (2010) developed questions based on three evaluation questionnaires: the System Usability Scale (SUS), the Usability and User Satisfaction Questionnaire (adapted from PSSUQ) (Zins et al., 2004), and the Web-based Learning Environment Instrument (WLEI) (Chang, 1999). Questions were added, removed and altered to meet the needs of criteria of this evaluation in this research. Excel and SPSS were used to analyse data from the questionnaire.

8.3.3.1. Readiness of Moodle

Table 8. 6: Readiness of Moodle.

		Mean	Std. Deviation	%
1	Were the introduction, workshops and training provided by the researcher prior to the use of Moodle beneficial?	4.80	.422	96.0
2	Was the tutorial provided helpful for using Moodle?	4.90	.316	98.0
	Average	4.85	.369	97.0
3	Have you been able to access Moodle all the time?	1.00	.000	50.0

Discussion of the Results

The results of the first three questions show that the teachers were satisfied with the introductory workshops and training conducted to introduce Moodle to them. They also show that this step helped them to comprehend how to use Moodle. However, the results for the second question indicate that the teachers used the tutorial given, which contradicts what was stated in the semi-structured interviews. This means that the teachers used the tutorials at certain times and found them as easy to read and apply as they found the workshops and training. The only explanation for this contradiction is that, during the interviews, the teachers felt embarrassed about confessing that they had used the tutorials.

This indicates that the workshops and training were not enough, possibly as they were conducted in two sessions over one day. However, the two methods have complemented each other and covered any gaps.

All of the teachers indicated that they were able to access Moodle at all times which shows that it was accessible and there were no problems in this respect. Moreover, this indicates that the host server was fully operational during the running time.

8.3.3.2. Moodle's Usability and User Satisfaction

This includes Moodle's design, functionality, ease-of-use, learnability, user satisfaction and the users' willingness to use Moodle again in the future.

Moodle's Design

Table 8. 7: The usability of and user satisfaction with the Moodle's design.

		Mean	Std. Deviation	Percent
4	I liked using the interface of the Moodle system	4.80	.422	96.0
5	My pupils liked and enjoyed using the Moodle interface	4.70	.483	94.0
6	The interface of Moodle was pleasant to use	4.80	.422	96.0
	Average	4.766	.442	95.3

Discussion of the Results

Questions 4-6 reveal a high level of satisfaction from the teachers about the way Moodle looked during the running time. The interface proved to be attractive and eye-catching and the deaf pupils enjoyed both the themes and the interface, based on their teachers' observation of them while they were using Moodle. The importance of this aspect is emphasised by Watzman and Re (2008) who include the font size, simplicity of the interface, icons and colours of the interface in the criteria that should be considered. This concurs with the fact that deaf pupils use their visual sensory as a main input and depend on it exclusively to process information (Wang, 2006).

Based on the above results, it can be concluded that Moodle's design was effective and successful in facilitating its use and both teachers and their deaf pupils were satisfied with it.

8.3.3.3. Moodle's Functionality

Table 8. 8: The usability of and user satisfaction with Moodle's functionality.

		Mean	Std. Deviation	Percent
7	Moodle has all the functions and capabilities that I expect it to have to help my deaf pupils	4.30	.675	86.0
8	The information retrieved by the system was effective in helping me to track my pupils' progress	4.10	.738	82.0
	Average	4.20	.7065	84.0

Discussion of the Results

Questions 7 and 8 demonstrate that the teachers were satisfied with Moodle functionalities such as student tracking, course logs, user management and the other tools and services that were available for them to use. Szalma & Hancock (2008) stress the importance in any HCI system of offering a pleasant experience to the users whilst they are interacting with the technology.

Based on the above results, it can be concluded that the Moodle functionality was effective and successful in providing a pleasant experience for teachers.

8.3.3.4. Ease of use

Table 8. 9: Usability of and user satisfaction with Moodle (ease of use).

		Mean	Std. Deviation	Percent
9	It was simple to use Moodle.	4.70	.483	94.0
10	The deaf pupils found it simple to use Moodle.	4.70	.483	94.0
11	It was easy to navigate between the content and the activities	4.90	.316	98.0
12	It was easy for the deaf pupils to navigate between the content and the activities	4.90	.316	98.0
13	Overall, Moodle was easy to use	4.90	.316	98.0
	Average	4.82	.3828	96.4

Discussion of the Results

Questions 9-13 show that the teachers were satisfied with Moodle's ease of use. Both teachers and their pupils found it easy to use. This is due to the simplicity of the interface and the clear functionalities and services Moodle offers. Moreover, Moodle offers two different methods of navigation. The ease of using web-based technology has been emphasised by Fogg, Cuellar & Danielson (2008). This, according to them, will improve website credibility. They count ease of use as a guideline for credibility research and web design (Fogg, Cuellar & Danielson, 2008).

Based on the above results, it can be concluded that Moodle was easy to use by the teachers and their deaf pupils.

8.3.3.5. Learnability

Table 8. 10: The usability of and user satisfaction with Moodle (Learnability)

		Mean	Std. Deviation	Percent
14	It was easy to learn to use Moodle	4.80	.422	96.0
15	There was too much information to read before I could use the system	1.30	.483	26.0
16	It was easy for the deaf pupils to learn to use Moodle	4.60	.516	92.0

Discussion of the Results

Questions 14-16 reveal that the teachers were highly satisfied with how easy it was to learn to use Moodle, for both them and their deaf pupils. Questions 14 and 16 have average means and percentages of 4.70 and 94%, demonstrating their satisfaction. Question 15, meanwhile, is phrased in the negative, meaning that the results demonstrate the degree to which the teachers disagreed with the question. If the question were re-stated in the opposite way, then a high mean would have been gained, which ultimately would have increased the average mean and percentage. The importance of the learnability aspect in this analysis comes from the fact that it is one component of the multimedia user interface (Sutcliffe, 2008). Sutcliffe (2008) describes learnability as one of the "key quality attributes" when "learning the product and its content" in a HCI context. Based on the above results, it can be concluded that Moodle was easy to learn by the teachers and their deaf pupils.

8.3.3.6. User Satisfaction

Table 8. 11: The usability of and user satisfaction with Moodle (Satisfaction).

		Mean	Std. Deviation	Percent
17	I felt comfortable using Moodle	4.70	.483	94.0
18	Using Moodle enabled me to deliver better teaching	4.80	.422	96.0
19	Overall, I am satisfied with Moodle	4.70	.483	94.0
	Average	4.73	.462	94.6

Discussion of the Results

According to Stanney & Cohn (2008), evaluators should consider the satisfaction factor of any evaluation targeting the usability of Virtual Environments (VE), into which category Moodle falls. Therefore, the satisfaction factor was assessed. Questions 17-19 reveal a high satisfaction level of 94.6% from the teachers about their satisfaction with using Moodle and regarding how Moodle enabled them to deliver better teaching. Therefore, it can be concluded that Moodle provided a satisfactory experience to the teachers.

8.3.3.7. Future Use of Moodle

Table 8. 12: The usability of and user satisfaction with Moodle (Outcome / Future Use).

		Mean	Std. Deviation	Percent
20	I will use Moodle in my future teaching	4.80	.422	96.0
21	I will recommend that my pupils use Moodle	5.00	.000	100.0
	Average	4.90	.211	98.0

Discussion of the Results

Questions 20 and 21 indicate a high degree of satisfaction with using Moodle, which has contributed to teachers saying that they will use Moodle in their future teaching and recommend and encourage their pupils to access Moodle. The agreement amongst the teachers is 98% on average across both using and recommending Moodle. Therefore, it can be concluded that Moodle provided a satisfactory experience to the teachers to such an extent that they will use it in their future teaching and recommend it to their pupils.

8.3.3.8. Learning Content

Table 8. 13: The accessibility, usability and user satisfaction regarding the learning content.

		Mean	Std. Deviation	Percent
22	Did you produce, author and use any learning content and materials that could be shared electronically via Moodle?	1.80	.422	90.0
23	Did you use this learning content and materials?	1.80	.422	90.0
24	Which material was preferred by the deaf pupils?	2.90	.738	58.0 (External)
		Mean	Std. Deviation	Percent
25	I was able to access the learning content and materials without much difficulty	4.40	.516	88.0
26	Pupils were able to access the learning content and materials without much difficulty	4.20	.422	84.0
	Average	4.30	.469	86.0

Discussion of the Results

This part of the questionnaire is targeted towards exploring the creation, use and access of learning content in Moodle. Questions 22 and 23 aim to find the percentage of teachers who created, authored and used their own learning content and materials, the results show that only 20% of the responding teachers created and authored their own learning content and materials and the only portion that used their created materials. Moreover, 50% of the teachers preferred to use learning content that they created together with their colleagues as it allowed them to produce better and broader learning

content and divide the workload involved instead of being solely responsible for it. Meanwhile, 30% preferred to produce learning materials as a PowerPoint slide show rather than in other formats. This is probably due to the teachers' lack of experience in creating and developing learning content and materials in the SCORM/AICC format. Only 20% of the teachers said that they relied on other teachers' content.

In terms of the accessibility of the learning content and materials, the teachers indicated that they were happy with their ability to access the (external) learning content in Moodle. This indicates that Moodle provides a satisfactory means of accessing learning content for both teachers and their deaf pupils.

8.3.3.9. Collaboration and Communication tools

Table 8. 14: The usability of and user satisfaction with collaboration and communication tools.

		Mean	Std. Deviation	Percent
27	Did you use the collaboration and communication tools?	1.00	.000	50.0
28	Which was your preferred communication medium in asynchronous mode with the deaf pupils?	1.60	.699	32.0 (Chat)
29	Which was the preferred communication medium of the deaf pupils in asynchronous mode?	1.30	.483	26.0 (Chat)
30	The collaboration and communication tools facilitated my teaching	4.00	.667	80.0
31	Instant messages (chat) were helpful to the deaf pupils	4.70	.483	94.0
32	Internal messages were helpful to the deaf pupils	4.80	.422	96.0
33	Forums were helpful to the deaf pupils	3.20	.789	64.0
34	Blogs were helpful to the deaf pupils	2.70	.823	54.0
	Average	3.88	.636	77.6

Discussion of the Results

This part of the questionnaire aimed to measure the satisfaction with accessing and using the collaboration and communication tools provided within Moodle. The results show that the teachers had all used the collaborative and communications tools offered by Moodle. Moreover, teachers preferred communication medium in asynchronous mode **with** the deaf pupils was instant messages (chat) with 50%, probably due to the immediate feedback gained through this medium. Internal messages (internal e-mail) indicated in 40% of the results as the preferred medium. Deaf pupils preferred

communication medium in asynchronous mode was also Instant messages (chat) with 70%, again followed by internal messages (internal e-mail) with 30%.

80% of the teachers indicated that the collaboration and communication tools had facilitated their teaching and communication with their deaf pupils. This means that the tools were suitable for the needs of both teachers and their pupils. The tracking system revealed that the tool that was most often used was instant messages. In conclusion, the teachers showed a moderate interest in using all the collaboration and communications tools (77.6%) with emphasis on using the internal and instant messages. Table 8.14 shows the most helpful tools for the deaf from teachers' perspectives.

8.4. SUMMARY

In this chapter, the different levels of the evaluation stage have been described. This included conducting semi-structured interviews and a questionnaire with the teachers to get their perceptions of using Moodle, and testing the pupils before and after using Moodle, to measure whether there had been any enhancement in their academic achievements in mathematics.

In the evaluation, Moodle's impact on the academic achievements of the deaf pupils was measured and compared these results with the previous year's achievements. Moodle was shown to have decreased the percentage of students failing and increased the percentage passing the tests.

The researcher evaluated Moodle's usability and user satisfaction. This included Moodle's learning content and materials, and collaboration and communication tools, as well as various aspects of using the system. The evaluation was carried out through the use of a questionnaire, which was complemented the semi-structured interviews and the Moodle tracking system. The results show that both teachers and the deaf pupils have a positive attitude towards Moodle. The next chapter is the last chapter and presents the conclusions and future work.

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

This thesis presents research carried out towards adopting and using open source LMS in Jordanian schools for the deaf. The process started by determining the current use of e-learning and open source LMS in Jordanian schools for the deaf, by both teachers and pupils. This step also included finding out about deficiencies in the current system and obstacles to using e-learning and LMS to teach deaf pupils in Jordan.

The decision to adopt the open source LMS "Moodle" was based on the evaluation of four different open source LMS. Surveys and interviews with teachers involved in the project were conducted and analysed them to produce a list of recommendations and requirements, which were then used in the evaluation. These requirements included administrative tools, customisation, communication tools and assessment tools. This enables the determination the most suitable open source LMS for the deaf Jordanian pupils and their teachers.

Using Moodle has provided the teachers with the opportunity to share resources among themselves and ultimately amongst all of the participating schools. This resulted in more resources being available for the deaf pupils and their teachers.

In this chapter, the general outcomes and major conclusions of the research are presented. Finally, details are given of future work that could be carried out, based on the approach used here and the outcomes of this research.

9.1. CONCLUSIONS

Chapter Two contained an extensive literature review based around a suitable, interdisciplinary range of topics, including the theoretical conceptualisation of deafness, the situation of deaf education in Jordan, theoretical background of e-learning with particular focus on e-learning for the deaf and statistical information about deafness and the education system in Jordan.

In more detail, Chapter Two presented the current situation for the deaf in Jordan, the educational services provided and current practices and legislation. It also highlighted the theme of the inappropriateness/failings of deaf education in Jordan.

The statistical information includes the number of deaf persons in Jordan and the number of schools, the number of educated deaf people, and their qualifications. This information highlighted the importance of conducting this research within the Jordanian context. All of the above serves as an up-to-date review of the circumstances of the deaf in Jordan that could be used in future research or to inform polices within the Jordanian context.

One of the main findings of chapter 2 is that 60.1- 62.6% of deaf between 5-19 years old are not receiving education or not attending schools in Jordan. This percentage came from the fact that only around 1,450-1,550 deaf pupils out of 3,876 are attending schools. These accurate figures conclude with Hendriks (2008) claims and explain why deaf people in Jordan are engaged in manual labour such as car maintenance, carpentry or factory work.

Chapter Three described the learning, education, training terminologies, learning theories and their implication in the e-learning field, the e-learning terminologies and classification, e-learning components, e-learning and deafness and new trends in e-learning. One of the main findings of chapter three is that the proper e-learning classification to be used in the Jordanian context for the deaf is the Asynchronous and the Blended/Hybrid Synchronous mode of delivery. The justification for that is due to these classification and mode of deliveries suites the school and class environment. The Asynchronous has been applied during schools time (8:00 am – 2:59 pm). The Blended/Hybrid Synchronous has been applied during off schools time (3:00 pm – 7:59 am).

Another finding is that in conclusion there is a substantial minimal consideration seems to be devoted to the development of e-learning platforms for improving the mathematical skills of deaf children. However, considerably more attention has been devoted to the development of the Sign language and the language of the countries that the deaf belongs and live within. Moreover, such projects are mainly targeting deaf

adults. Due to the signing diversity it is difficult to make use of such or any other system.

Chapter Four described the research methodologies used, namely action research and HCI-related research. The data collection methods used in this research was questionnaires, semi-structured interviews, pre/post tests and web-based observation (using a tracking tool within Moodle). Epistemologies and justifications for using such methodologies were discussed in order to illustrate their appropriateness. Lastly, the suitability of various data analysis methods was discussed.

Chapter Five investigated the current level of use of e-learning in Jordanian schools for the deaf and the main problems facing deaf pupils when learning mathematics. The findings of this chapter indicates that there is an acknowledged lack of use of e-learning and LMS within Jordanian schools for the deaf, with the main focus and support going on mainstream schools. This has resulted in a lack of specialised Arabic e-learning and LMS systems. In addition there is the lack of local learning content and objects and experience in using such technologies, which all present further complications (The Arab Knowledge Report, 2009; AL-Ja'am et al, 2008). The 64.6% of the teachers surveyed indicated that the main reason for not using e-learning and LMS in the schools was the lack of specialised Arabic systems. A further 16.9% indicated that the main reason was a lack of training. The 66.2% of the teachers said that the deaf pupils did not use the current ICT infrastructure (i.e., computers in the schools).

Similar to their counterparts across the world, deaf pupils in Jordan have problems when learning mathematics, according to their teachers, and so far no action has been taken to overcome their difficulties. Problems faced by the deaf when learning mathematics have been reported by Drigas et al (2005a, b), Zarfaty et al (2004) and many other mentioned in previous chapters.

There is an acknowledged lack of communication between teachers and the deaf pupils, due to a lack of preparation programs and training for teachers. There is also a problem in that there is no unified sign language across Jordanian schools. Moreover, the results given in Chapter Five showed that the MoE in Jordan has much less interest in investing in deaf education compared to the mainstream schools. It was found that there was no

proper training given to teachers on using e-learning and ICT. 67.7% of the teachers indicated that they had never used e-learning in their teaching and 89.2% felt that the existing teaching tools were not sufficient. Of the teachers 49.2% said that they had never used an LMS and 35.4% did not know about LMS.

Chapter five contributed to the research project by defining the services and tools that LMS should provide in order to meet the needs of the teachers and their deaf pupils, in terms of accessibility, collaborative and communication tools, usability and interoperability. This information contributed towards the choice of Moodle over the other open source LMS evaluated. However, Chapter five findings that can be summarised as the follows:

Teaching method

The teachers use the conventional method of teaching and it is not possible for the teacher to give one-on-one attention to their students. Moreover, this method transforms the students' roles from active to passive. In addition, this method does not accommodate the different learning styles.

Teacher's qualifications

Teachers of the deaf in Jordan are not fully qualified to teach deaf pupils on both qualification and subjects they are teaching. In addition, there is a lack of training and support from the MOE and universities programs. Experience is the main factor that the teachers rely on when teaching deaf pupils and they use this to overcome their deficiencies in trainings, qualifications and communication skills.

Lack of Communication

There is a lack of communication (competency in sign language, lip-reading and total communication) this is more discussed in chapter five.

Lack of Resources

This study revealed the lack of internal and external resources and their availability for deaf pupils and their teachers. Of the 3,373 e-learning lessons created for various subjects none have been used by deaf pupils in Jordan. Moreover, 67.69% of teacher reported that they never make use of available tools in their teaching.

Access to the support of teachers and colleagues and learning materials

This is another issue has been revealed by this research, the outcome showed that there is a lack in support between the teachers-pupils, pupils-pupils and teachers-teachers. This resulted in little collaboration between teachers and pupils, teachers and other teachers and deaf pupils among themselves. Another issue is that deaf pupils are isolated when they are outside of the school (summer holidays, weekends, at home... etc.).

Teachers' recommendations and requests for e-learning system features

In the Jordanian context and other similar contexts, the outcome of this research could be applied taking into consideration the uniqueness of each context. However, when implementing such projects there are specific features that should be considered. Another feature that should be considered is the dependablity aspects of e-learning. The dependablity aspects are the accessibility, interoperability, reusability and adaptability. These features have a direct impact on the evlaution process, the implementation and use of the LMS. These features came in an indirect way through the responses of the teachers in chapter five.

Chapter six provided details of the systematic review carried out on existing open source LMS, including the evaluation of four open source LMS. "Moodle" was chosen as the best system for the purposes of this research. The evaluation used the teachers' feedback to in developing the key requirement used to evaluate the four open source LMS.

The main outcome of chapter six is the validation and the usefulness of the methodology used in the evaluation. The systematic methodology used met the four essentials mentioned by Al-Daoud et al. (2008) namely, the student management, the broadcasting of knowledge among the users, the ability of assessing the progress of absorption and the communication amongst users. Moreover, the methodological approach used in evaluating the open source LMS has contributed to the methodological approaches in software engineering and LMS/LCMS evaluation and analysis.

The teachers' key responses to the first questionnaire in chapter five has contributed in evaluating and analysing four open source LMSs'. The responses mainly translated into

the main features that should be available and supported by any LMS will be used by deaf people mainly and hearing people in broader terms.

Chapter Seven explained the procedures and processes carried out to implement Moodle within the participating schools. Moreover, ethical considerations were addressed in order to guarantee smooth and successful implementations.

The main contribution was the successful implementation of the theoretical framework proposed. The theoretical framework consisted of two parts, the first part is the research methodology employed in this research (action research) and the second part is the Waterfall System Development Life Cycle (Waterfall SDLC).

One of the main outcomes of this chapter is the integrated process involved to complement each process from both cycles. This could be seen through the integrated process of both cycles in research design. This came from finding the similarities and links between the processes of both cycles. The theoretical framework is explained in the methodology chapter (chapter four, figure 4.1) and in chapter seven as well.

Chapter seven defines a description for the suitable e-learning and LMS to be used by the deaf in Jordan and in other contexts. This could be seen on different levels of the system such as the scalability, interoperability, availability and security. The existence of such aspects in any e-learning system for the deaf is imperative and crucial; such aspects will guarantee smooth, flexible and enriching experience for deaf users.

Other aspects proved to be very successful in the delivery of learning content for the deaf pupils in this research is the content delivery structure. This proved to be very important as it has very significant effect on access and delivery of the learning content for the deaf pupils. The most successful course structure used in this research was the topic format.

Chapter Eight describes the evaluation processes and procedures carried out to assess the effectiveness of using Moodle, measured through the deaf pupils' achievements and the users' experiences and attitudes towards Moodle. The results showed that the users had a positive attitude towards Moodle and e-learning. Moreover, the results showed

that their use had enhanced the deaf pupils' academic achievements in mathematics, compared to the previous year's results and the pre-test results.

From these findings, it can be concluded that the systematic and methodological approach used in this research has been successful in terms of producing guidelines for adopting open source LMS and e-learning within the Jordanian context. Such success was proven through the academic achievements of the deaf pupils, the information obtained through the tracking tool regarding the use of Moodle and the teachers' responses about their use of Moodle.

This research has covered an area that is severely under-studied, especially in the Arabic world, but also across the world in general, as was shown by the literature review. Moreover, the researcher has targeted a highly multidisciplinary research area of significant importance in education and particularly to the deaf.

9.2. RECOMMENDATIONS FOR FUTURE WORK

This research has provided initial guidelines for adopting open source LMS within Jordanian schools for the deaf. It has provided an open source LMS for deaf pupils and teachers and helped them to solve the problems they were facing inside the classroom, whilst learning in general but learning mathematics in particular. This could be used for further research into other areas of deaf education in Jordan and the Arab world. Moreover, using Moodle to deliver e-learning for the deaf pupils and teachers has increased awareness of such systems in Jordan and hopefully demonstrates how it could be used in other contexts with similar requirements in the future. In this section, the researcher points out some ideas for future work.

This project could be adopted by the MOE in Jordan and within special education departments within Jordanian universities to enhance deaf education in Jordan. Projects could be carried out in the following areas:

9.2.1. Development of Specialised E-Learning Systems

Specialised e-learning systems could be geared towards the specific demands of teaching deaf and other special needs pupils in Jordan. This could be achieved via professional localising of open source LMS such as Moodle to Arabic language and other languages in similar contexts.

9.2.2. The Development of Specialised Learning Content

Learning content (learning content via sign language) could be steered towards deaf needs. As mentioned, there is an acknowledged lack of learning content and materials in Jordan that are designed for deaf people. Moreover, such resources could be delivered using sign language (video format). However, this would require more time and resources, especially to deliver content covering other subjects, such as English, Arabic, science, etc.

This could lead to the development of a specialised curriculum and a unified sign language across Jordan. Moreover, the accessibility of learning content could be improved as it is easier to share such resources among deaf users using e-learning.

9.2.3. The Development of New Ways of Collaboration and Communication

Further research could be carried out, based on the outcomes of this research, into other areas of deaf education, such as learning sign language and other languages (English and Arabic, for example) to promote communication for the deaf in Jordan particularly and in the world.

Further research could be carried out, based on the outcome of this research, into the usability and the effectiveness of collaboration and communication tools available online such as chatting, forum's, blogs and video conferencing.

9.2.4. Implementing Bilingual Deaf Education within the Jordanian Context

The findings of this research and Moodle could be used to provide better approaches in implementing bilingual deaf education and the use of sign language in the classroom by providing specialised learning content and materials that teach sign language to deaf

pupils. This could be achieved by allocating daily classes to the subject of sign language and using e-learning.

9.2.5. Establishment of private or governmental Institutional Body

The Jordanian government should establish an institutional body with the aim of providing the necessary skills and education to support lifelong vocational and educational training, incorporating e-learning for deaf people in Jordan. The institutional body could make use of the systematic approach used in this research in order to deliver appropriate training and deaf education.

9.2.6. Higher Education in Jordan

Universities in Jordan can build on the findings of this research to deliver e-learning to deaf students at the undergraduate and postgraduate levels. This will increase the access of such technology within the higher education for the deaf people.

The Universities in Jordan can include the use of such systems in their preparation programs. This will solve some of the problems mentioned in chapter five that face the teachers when using such technology in their teaching. Moreover, it will enhance their teaching to the deaf and offer alternative methods for delivering the learning content for their deaf students.

9.2.7. Replicating and Extending

This research sets a guideline in reproducing the research in different subjects such as English, Arabic, Science and other subjects for different levels for the deaf education in Jordan and in other similar contexts. Moreover, this research could be extended to deliver university training programs for deaf in higher education.

The research sets guidelines for the adoption of similar e-learning systems and LMS's into the mainstream education in Jordan and other contexts on school and higher education levels.

9.2.8. Recording Classes

In order to complement the benefits of using e-learning and LMS, it would be extremely helpful to record and video tape all classes and upload them to the LMS so that deaf

pupils can fully review the classes they have attended. This would also be of assistance to deaf pupils who had missed certain classes. This approach would allow the deaf pupils to review their classes at their own pace. It could also be used to assess teachers for teaching quality assurance purposes.

Finally, as mentioned before there is a lack of research into the use of e-learning and open source LMS for the deaf children? The novelty of this research comes from the fact it is the only research has been carried out in terms of delivering mathematics for the deaf in pupils in Jordan. To the best of the researcher knowledge there is no research published in this area. Another novelty of this research comes from the fact that this research has covered an area that is severely under-studied, especially in the Arabic world and in Jordan in particular, but also across the world in general, as was shown by the literature review. Moreover, the researcher has targeted a highly multidisciplinary research area.

Appendices

Appendix A: INTERVEWS NOTES

Appendix A

Interview Note (1) used in chapter 5

The following is the interview schedule has been asked to teachers of mathematics who participated in this study.

Firstly I would like to thank you for your participation in this project, which is aiming to help deaf children in your class to enhance their mathematical skills and provide you a supplementary tool that you can use (as teacher) to teach mathematics. I would be delighted if you could answer the following questions.

In this part of the questions in the interview, the researcher aim was to answers to the following questions:

1. *What is your method of teaching mathematics to the deaf?*
2. *What are the topics you think it is hard for deaf children to learn in mathematics?*
3. *Why do you think it is hard for deaf children to learn these topics in mathematics?*
4. *How do you clarify difficult topics and concepts in mathematics?*
5. *Does the use of lip-reading and sign language enable you to present and explain mathematics in a clear way?*
6. *Do you have any software (E-learning and LMS's) or have you developed any presentations to help you to teach mathematics at the elementary level?*
7. *Do you find that varying the methods used to deliver learning materials helps children to learn mathematics?*
8. *What sort of features should an e-learning system provide to you and your deaf pupils?*

Appendix A

Interview Note (2) used in chapter 8

The following is the interview schedule has been asked to teachers of mathematics who participated in this study.

Firstly I would like to thank you for your participation in this project, which is aiming to help deaf children in your class to enhance their mathematical skills and provide you a supplementary tool that you can use (as teacher) to teach mathematics. I would be delighted if you could answer the following questions.

After using Moodle, can you tell me your perceptions toward Moodle and e-learning in terms of the following?

1. *e-learning (redefining learning)*
2. *The effectiveness of the workshops and tutorial*
3. *Monitoring the students*
4. *Access Modes*
5. *The Use of Moodle*
6. *Resources and Learning Content*
7. *Navigation*
8. *Interactive Content*
9. *Accessing and sharing the learning content and resources*
10. *Access to activities (communication and collaboration tools)*
11. *Use of Instant Messages (Chat)*
12. *Use of Blogs*
13. *Use of Dimdim*
14. *Use of Internal Messages*
15. *Use of Forums*

Appendix B: QUESTIONNAIRES

Appendix B: Questionnaire (1)

Used in defining the current status and sue of e-learning within the Jordanian schools for the deaf Chapter 5.

Items (Questions)	
Age	26-31 years
	32-37 years
	38-42 years
	43-48 years
Gender	Male
	Female
Teach Mathematics	Yes
	No
Years of experience teaching deaf students	1-3 Years
	4-6 Years
	7-9 Years
	More than 9 years
Number of topics taught by teachers	One Topic
	Two Topics
	Three Topics
	Four Topics
	More than Four Topics
The ability to use the productivity packages and operating system	Unable to use
	Very difficult to use
	Able to use with some difficulties
	Able to use with little difficulty
	Able to use without any difficulty
The ability to use the Internet (such as downloading and uploading files, searching and browsing)	Unable to use
	Very difficult to use
	Able to use with some difficulty
	Able to use with little difficulty
	Able to use without any difficulty
Do you have an e-mail	Yes
	No

Number of PCs available and used in your school	One to Three PCs
	Four to Six PCs
	Seven to Nine PCs
	Ten to Twelve PCs
	More than Thirteen PCs
Number of users per PC in computer labs	1 User/PC
	2 Users/PC

	3 Users/PC
	4 Users/PC
	5 Users/PC
How often do the deaf pupils have access to the computers inside the school?	None or never used it
	on a daily bases or more often
	on a weekly bases or more often
	on a monthly bases or more often
	on a semester bases or more often
Do you think computers and the Internet are necessary for teaching deaf students?	Yes
	No
How frequently do you use computers and the Internet (e-learning) in your teaching?	Always
	Often
	Occasionally
	Rarely
	Never
The reasons behind not using e-learning and LMS in the schools	Lack of Confidence
	Lack of Specialised Software
	Lack of Hardware
	Lack of Training
	Educational Policies
Have you ever used any LMS or does your organisation use it?	Yes
	I don't know what is LMS
	No
Do you think that the current teaching tools are sufficient?	Yes
	No

Tools /Availability	Widely available	Available	Few	Rare	None or Not available
Conventional Teaching Tools (wooden crafted shapes, pens or other physical objects)					
Illustrations					
Books (Outside of the Curriculum)					
Educational TV and Broadcasting (Live)					
Animations					
Other Files (Such as PDF, Doc)					
CD and DVD's					
Webpages (HTML Pages)					
Presentations and Power Point Slides					
Software Packages (Open Source or Commercial)					
Online Collaborative Tools (Forums, Blogs and Chatting Software)					

Appendix B: Questionnaire (2)

Used assess the readiness, usability and user satisfaction of Moodle. This questionnaire were discussed in chapter 8

- ***Readiness of Moodle***

Questions	Highly Beneficial	Moderate Benefit	Limited Benefit	Not Beneficial	Not Used
Were the introduction, workshops and training provided by the researcher prior to the use of Moodle beneficial?					
Was the tutorial provided helpful for using Moodle?					
The interface of Moodle was pleasant to use	Yes				
	No				

- ***Moodle Usability and User Satisfaction***

The usability and user satisfaction includes Moodle design, Moodle functionality, Moodle ease of use, Learnability, Moodle user satisfaction and willingness to use Moodle in the future.

Questions	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
I liked using the interface of Moodle system					
My pupils liked and enjoyed using the Moodle interface					
The interface of Moodle was pleasant to use					
Moodle has all the functions and capabilities that I expect it to have to help my deaf pupils					
The information retrieved by the system was effective in helping me to track my pupils' progress					
It was simple to use Moodle.					
The deaf pupils found it simple to use Moodle.					
It was easy to navigate between the content and the activities					
It was easy for deaf pupil to navigate between the content and the activities					
Overall, Moodle was easy to use.					
It was easy to learn to use Moodle					

There was too much information to read before I can use the system					
It was easy for deaf pupils to learn to use Moodle					
I felt comfortable using Moodle					
Using Moodle enabled me to deliver better teaching					
Overall, I am satisfied with Moodle					
I will use Moodle in my future teaching					
I will recommend that my pupils use Moodle					

- ***Learning Content***

The interface of Moodle was pleasant to use			Yes		
			No		
The interface of Moodle was pleasant to use			Yes		
			No		
Questions	Own developed through Moodle	Own developed through other formats such as power Point, etc.	Collaborating with others (developing resources as part of a team)	Internal learning content (developed by the teachers)	External from other websites (developed by others – not teachers)
Which material was preferred by the deaf pupils?					
Questions	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
I was able to access the learning content and materials without much difficulty					
Pupils were able to access the learning content and materials without much difficulty					

- ***Collaboration and Communication tools***

Did you use the collaboration and communication tools?	Yes			
	No			
Question	Instant messages (chat)	Internal messages	forums	blogs
Which was more preferred communication medium in asynchronous mode with the deaf pupils				
Which was the preferred communication medium of the deaf pupils in asynchronous mode?				

Questions	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Collaboration and Communication tools facilitated my teaching					
Instant messages (chat) were helpful pupils					
Internal messages were helpful to deaf pupils					
Forums were helpful to deaf pupils					
Blogs were helpful to deaf pupils					

Appendix C: MOE PERMISSION

Appendix C: MoE Permission to conduct this research in Jordan.

بسم الله الرحمن الرحيم

وزارة التربية والتعليم

١١٥٥

الرقم: ٣/ ١٠ التاريخ ٢/ ١٢/ ٢٧/ ١٤ الموافق ١ / ١ / ٢٠٠٧

السيد مدير التربية والتعليم لمحافظة/ لمنطقة / للواء..........

الموضوع : البحث التربوي

السلام عليكم ورحمة الله وبركاته،

يقوم الطالب سفيان محمد الخوالدة بدراسة بعنوان " استخدام التعليم الإلكتروني في تحسين مهارات الرياضيات للطلاب الصم في الصف الثالث الأساسي في المملكة الأردنية الهاشمية "، وذلك استكمالا لمتطلبات الحصول على درجة الدكتوراه في التعليم الإلكتروني من جامعة انجليا رسكن في بريطانيا، ويحتاج ذلك مقابلة المعلمين الذين يدرسون مادة الرياضيات لطلبة الصم في الصف الثالث الأساسي، وحضور حصص صفية لملاحظة مدى تفاعل الطلبة مع البرنامج التعليمي في المدارس التابعة لمديريتكم .

يرجى تسهيل مهمة الطالب المذكور وتقديم المساعدة الممكنة له.

مع وافر الاحترام

/ وزير التربية والتعليم

الدكتور قاسم سليمان القضاة

مدير المطبوعات التربوية

نسخة /الآنسة رئيس قسم البحث التربوي
نسخة / للملف ٣/ ١٠

هاتف: ٥٦٠٧١٨١/ ١١ فاكس: ٥٦٦٦٠١٩ ص.ب: (١٦٤٦)

Appendix D: RELATED AUTHOR'S PUBLICATIONS

Declaration

Some of the material contained in this dissertation has been presented in the following publications:

- Khwaldeh, S., Shah, M., & Ahmed, W. (2011). The effectiveness of Open Source Learning Management System (LMS) "Moodle" for deaf pupils in Jordan. *International Conference on Data Engineering and Internet Technology (DEIT 2011).* Bali, Indonesia: IEEE Xplore Digital Library.

- Khwaldeh, S., & Shah, M. (2010). The adaptability of an open source learning management system for deaf children in Jordan. *The 2nd IEEE International Conference on Information Management and Engineering (IEEE ICIME 2010)* (pp. 34-39). Chengdu, China: IEEE Xplore Digital Library.

- Khwaldeh, S. Shah, M. (2009) The Evaluation and Adaptation of LMS for Deaf children in Jordan, International Asian Conference on Education, held in Osaka, Japan, October 25, 2009.

- Khwaldeh, S. M., Matar, N., & Hunaiti, Z. (2007). Interactivity in Centralised e-learning System for the Deaf in Jordan. *the 8th Annual Postgraduate Symposium on the Convergence of Telecommunications, Networking & broadcasting* (pp. 292-295). Liverpool: The School of Computing and Mathematical sciences, Liverpool John Moores University.

- Matar, N., Khwaldeh, S. and Hunaiti, Z. (2007), Adaptive Unified E-learning System for Supporting Better E-learning Approach, *the 8th Annual Postgraduate Symposium on the Convergence of Telecommunications, Networking & broadcasting* (pp. 303-306). Liverpool: The School of Computing and Mathematical sciences, Liverpool John Moores University.

Appendix E: LETTERS TO THE TEACHERS, PARENTS/GUARDIANS AND DEAF PUPILS

Teacher Letter

Sufian Khwaldeh
Lancashire Business School,
University of Central Lancashire,
Preston PR1 2HE

Title of Research Project:

Implementation, use and analysis of open source LMS's "Moodle" and e-learning for the deaf in Jordan

Dear Teacher

I am a research student from the University of Central Lancashire in the UK. I am planning to use computer software to help deaf children in the third grade learn mathematics. Your school has kindly agreed to take part in this project. I would be delighted if you would assist me in this study.

It would be very helpful for me if you would share with me your experience of teaching deaf pupils. During the course of this project I would like to conduct semi-structured interviews with you, firstly to understand any problems facing deaf pupils in learning mathematics, and later on, to evaluate the effectiveness of the software I will be using. I need to understand the present educational system and the factors that may encourage or discourage you and the pupils from using e-learning as an aid to learning. These interviews will be conversational in style so that you can express your own personal views on effective mathematics teaching.

Your feedback will enable me to enhance the software and I may ask you to test it more than once to ensure that it satisfies your requirements. Subsequently I will invite you to ask the pupils to test it. Then I would like to observe you and the children using the e-learning tool.

I would expect this e-learning tool to supplement your teaching and not replace it. I will be seeking permission from the pupils and their parents/guardians to participate in my project. I also want to be certain that any pupils who do not participate in this project will not be disadvantaged in any way.

At The University of Central Lancashire I have submitted my research proposal for approval; this includes obtaining ethics approval to ensure I follow approved procedures for working in a school.

Please find enclosed with this letter two copies of the consent form and the withdrawal form. Please complete both copies of the consent form, return one to me and keep the other copy for your records.

I do hope that you will want to participate in my research. I am more than happy to discuss this project with you in greater details. I look forward to working with you.

Yours sincerely

Sufian Khwaldeh

Teacher Consent form

Sufian Khwaldeh
Lancashire Business School,
Green bank Building, University of Central Lancashire,
Preston PR1 2HE

Implementation, use and analysis of open source LMS's "Moodle" and e-learning for the deaf in Jordan

1. I agree to take part in the above research. I have read the letter that is attached to this form. I understand my role in this research, and all my questions have been answered to my satisfaction.
2. I understand that I am free to withdraw from the research at any time, for any reason and without prejudice by completing the withdrawal form attached
3. I am free to ask any questions at any time before and during the study.
4. I have been provided with a copy of this form and the letter.
5. I understand all information provided will be treated as confidential and anonymity will be safeguarded by applying the following approaches: the researcher will use pseudonyms when quoting or referring to individuals. The researcher will not use the personal details or full names (which means first name and surname) of any child or adult.
6. Additional consent will be sought if the researcher wishes to make any further use of the material beyond the scope of this project.
7. The researcher will ensure that all collected information and data is securely archived throughout the life of the project.
8. Upon completion of this project all data will be destroyed.

To comply with the British Data Protection Act 1998, the researcher needs your permission for your participation in this project. Please answer questions below, then sign and date this form where shown.

May the researcher use your feedback and any information relating to the e-learning tool for research purposes only?	Yes No

Data Protection: I agree to Sufian Khwaldeh, a research student at The University of Central Lancashire - UK processing **anonymised** data regarding class test results, observation, and interviews for any purposes connected with the Research Project.

Signed…….....……

Name (print)……..…….....……

Date…….....

Teacher Withdrawal Form

Main investigator and contact details:
Sufian Khwaldeh
Lancashire Business School,
Green bank Building, University of Central Lancashire,
Preston PR1 2HE

Title of Research Project:

Implementation, use and analysis of open source LMS's "Moodle" and e-learning for the deaf in Jordan

Withdrawals from the research project.

If you wish to withdraw from the research, please complete the attached form below and return to the main investigator named below.

I WISH TO WITHDRAW FROM THIS STUDY

Signed…….....……

Name (print)……..…….....……

Date…….....

Parents/Guardian Letter

Sufian Khwaldeh
Lancashire Business School,
Green bank Building, University of Central Lancashire,
Preston PR1 2HE

Title of Research Project:

Implementation, use and analysis of open source LMS's "Moodle" and e-learning for the deaf in Jordan

Dear Parents/Guardian
I am a research student from The University of Central Lancashire in the UK. I am planning to help deaf children learn mathematics by using a computer based learning. _____ School has kindly agreed to take part in this project. I am seeking your permission for your child to participate in this project.

I wish to know how computer based learning may help deaf pupils understand mathematics, and ascertain the impact that using computer-based learning may have on the achievements of deaf pupils. I would expect this computer software to supplement the conventional teaching and not replace it.

To help me understand the teacher's perspective regarding how deaf pupils learn mathematics and any problems that they face, I plan to conduct interviews with the teachers and also observe the pupils learning mathematics. When I have used the proposed software, I will ask the teacher to test this and would then like the pupils to use it. Their feedback on the software will be very helpful and enable me to improve the software to hopefully give maximum benefit to the children. I will observe the pupil's attitudes toward the computer software when learning mathematics. The observation will take place inside the classroom with your child teacher present. At no time will your child be separated from their peers or the teachers. Finally, the effectiveness of the e-learning tool will be judged by monitoring test results and undertaking further semi-structured interviews with the teachers.

The proposed computer based learning will be designed to supplement conventional mathematics teaching. Thus pupils who do not participate will not be disadvantaged. They will continue their class normal.

Parents/Guardian Letter

Sufian Khwaldeh
Lancashire Business School,
Green bank Building, University of Central Lancashire,
Preston PR1 2HE

However the aim of my research is to help deaf children and thus I do hope you will give permission for your child to use the software I am using. The pupil's responses will be invaluable in helping me to produce computer-based learning that effectively enhances their understanding of mathematics.

I will be seeking permission from the teachers to participate in my project. I also want to be certain that any pupils who do not participate in this project will not be disadvantaged in any way.
Upon completion of the e-learning tool I would be very pleased to give your child a copy of the software for their use at home.

I confirm that all information will remain completely confidential. No child will be identified by name.

Please find enclosed with this letter two copies of the consent form and the withdrawal form. Please complete both copies of the consent form, return one to me and keep the other copy for your records.

If you give permission for your child to participate, please sign and return the attached form to your child's school. I am more than happy to discuss this project with you. Please do not hesitate to contact me if you have any queries.

Yours sincerely

Sufian Khwaldeh

Parents/Guardian Consent form

Sufian Khwaldeh
Lancashire Business School,
Green bank Building, University of Central Lancashire,
Preston PR1 2HE

Implementation, use and analysis of open source LMS's "Moodle" and e-learning for the deaf in Jordan

1. I agree for my son/daughter _____to take part in the above research. I have read the letter which is attached to this form. I understand what my son's /daughter's role will be in this research, and all my questions have been answered to my satisfaction.
2. I understand that I am free to withdraw my son/daughter from the research at any time, for any reason and without prejudice by completing the withdrawal form attached. Withdrawal will not interfere with my child's care or learning experiences in their classroom and my child will continue to be provided with developmentally appropriate activities and experiences.
3. I am free to ask any questions at any time before and during the study.
4. I have been provided with a copy of this form and the letter.
5. I understand all information provided will be treated as **confidential** and **anonymity** will be safeguarded for school, teacher, and class by applying the following approaches: the researcher will use pseudonyms when quoting or referring to individuals. The researcher will not use the personal details or full names (which means first name and surname) of any child or adult.
6. Additional consent will be sought if the researcher wishes to make any further use of the material beyond the scope of this project.
7. The researcher will ensure that all collected information and data is securely archived throughout the life of the project.
8. Upon completion of this project all data will be destroyed.

To comply with the British Data Protection Act 1998, the researcher needs your permission for your child to participate in the project. Please answer questions below, then sign and date this form where shown.

May the researcher use your child's feedback and any information relating to the e-learning tool for research purposes only?	Yes No

Data Protection: I agree to Sufian Khwaldeh, a research student at The University of Central Lancashire - UK processing **anonymised** data regarding class test results and observation for any purposes connected with the Research Project.

Signed…….....……
Name (print)……..…….....……
Date…….....

Parents/Guardian Withdrawal Form

Sufian Khwaldeh
Lancashire Business School,
Green bank Building, University of Central Lancashire,
Preston PR1 2HE

Implementation, use and analysis of open source LMS's "Moodle" and e-learning for the deaf in Jordan

Withdrawal from the research project

If you wish to withdraw from the research, please complete the attached form below and return to the class teacher at ……. school.

I WISH TO WITHDRAW MY SON/DAUGHTER FROM THIS STUDY

Signed…….....……
Name (print)……..…….....……
Date…….....

Pupils Letter

Sufian Khwaldeh
Lancashire Business School,
Green bank Building, University of Central Lancashire,
Preston PR1 2HE

Dear Student

Using computers to help you Learn Mathematics

Hello, my name is Sufian. I am studying at the University of Central Lancashire in the UK. I am planning to use a computer programme that I hope will help you and other pupils learn mathematics. Your teacher will be guiding me so that I can use a computer programme that aims to help you learn mathematics.

I hope you will enjoy this programme with your teacher present; I would like to observe your class using the programme so that I can learn how to improve it to make learning enjoyable more. It would be very helpful if you would tell your teachers what you think about it and give them your suggestions for improving it.

Before we run this computer programme in class, I will need your permission and the permission of your parent/guardian. I shall be delighted if you would take part in my project and use the computer programme but this is entirely voluntary. Your mathematics classes will continue as usual if you are not participating in this project. If you wish to leave the project, please hold up the red card attached to this letter when you are in the mathematics class. Please tell your teacher you wish to withdraw and complete the withdrawal form. If you have any more questions please ask your teacher.

Please find enclosed with this letter two copies of the consent form and the withdrawal form. Please complete both copies of the consent form, return one to me and keep the other copy for your records.

Sufian Khwaldeh

Pupils Consent form

Sufian Khwaldeh
Lancashire Business School,
Green bank Building, University of Central Lancashire,
Preston PR1 2HE

Using computers to help you Learn Mathematics

1. I agree to take part in the e-learning project. I have read the letter and understand what my role will be in this project.
2. All my questions have been answered and I understand the project.
3. I am free to leave the project if I wish by raising a red card and I will complete the withdrawal form attached. I can talk to my teacher about it.
4. I know the information I give will be kept in a safe place during the project and securely archived or destroyed at the end of the project. If you wish to make further use of this material, you will ask for my permission again in a separate form.
5. I am free to ask any questions at any time before and during the project to the teachers.
6. I have a copy of this form and the letter from Sufian Khwaldeh who is carrying out the project.

Signed……

Name (print)……..……. ……

Date……..

Pupils Withdrawal Form

Withdrawals form the research project.
Sufian Khwaldeh
Lancashire Business School,
Green bank Building, University of Central Lancashire,
Preston PR1 2HE

Using computers to help you Learn Mathematics

If you do not want to be part of this project any more please raise the red card in a mathematics class. Please tell your teacher you wish to withdraw and then sign this form and give it to your teacher.

I WISH TO WITHDRAW FROM THIS STUDY

Signed……

Name (print)……..……. ……

Date……..

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