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2008

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INTERACTIVE INTERFACES FOR PRESENTING ONLINE COURSES: AN EVALUATION STUDY

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Abstract

The use of the Internet for distributing information continues to grow. This is particularly evident within the area of e-learning. The widespread accessibility of the Internet offers a convenient medium for the delivery of learning content. A number of applications have been developed specifically to offer e-learning services to students while also providing a mechanism for tutors to present learning material. These web-based applications are often referred to as Learning Management System as they offer tools to manage information, including learning material and students' records. Despite their popularity, courses offered solely using such e-learning tools have a high attrition rate. The issue of retaining students is attributed to 2 main factors; the level of interaction with others, and how the information contained in the system is accessed. This paper examines these problems and describes CLEV-R and its mobile accompaniment mCLEV-R and their online learning interfaces, which provide 3D spaces as a mechanism for human computer interaction, combined with communication tools for students to collaborate. These systems have been evaluated through a usability study and the results presented in this paper indicate the paradigm adopted by CLEV-R and mCLEV-R provide substantial benefits when used as an interface for e-learning.

Keywords: E-Learning, M-Learning, Collaboration, Human Computer Interaction, Graphical User Interfaces.

1 INTRODUCTION

While information systems play a key role in many organisations, their use is not limited to business domains. Today, 'information systems' is a general term used to describe any means of processing, storing and accessing information within multiple disciplines. Our concern is with online learning and in particular providing access to course information and learning material. At present, Learning Management Systems (LMS) are the primary method used to deliver learning material online. These systems help course tutors to manage and deliver their learning resources and provide administrative and communication tools to aid students throughout their learning. Despite the growing use of LMSs within third level institutions, courses which rely solely on these e-learning techniques have problems retaining students (Serwatka 2005). High dropout rates are accredited to a number of factors. Firstly, as text is primarily used to present the learning material, boredom and a lack of motivation can be experienced by students (Zhang et al., 2004). Secondly, as communication within these systems tends to be asynchronous, feelings of isolation and loneliness can also be prevalent (Kamel-Boulos et al. 2005).

As mentioned above, the webpages used in LMSs predominantly provide access to learning resources through a text-based interface. Students must navigate through the text to locate relevant learning content. This type of interaction can require students to read large amounts of text on-screen which they may be reluctant to do (Anaraki 2004). In addition to creating a sense of ennui, these text-based interfaces can also prevent students from obtaining a clear understanding of the subject matter (Zhang et al. 2004). Thus, it is important to present online learning material to students in more stimulating ways so that their interest and motivation are retained.

Lack of interaction with others also contributes to the high attrition rates within online courses. Asynchronous online message boards and forums along with e-mail are the main communication channels currently provided in LMSs. Real-time communication is often not facilitated which can hinder the formation of social bonds between students and impede collaboration. Collaborating with ones peers is an important element of learning in the real world (Kitchen & McDougall 1998). Participating in group projects teaches students about cooperation and teamwork. Similarly, interaction with peers plays a key role in the personal development of students and their formation of social skills. However, the asynchronous mediums provided in conventional online learning applications do not lend themselves well to these types of tasks. As a result, students do not experience a social presence within an online learning community, a factor which contributes to the high dropout rates witnessed in online courses.

To address these issues we have developed an interface for e-learning called Collaborative Learning Environments with Virtual Reality (CLEV-R), which uses an interactive onscreen 3D environment to provide access to learning material in a stimulating and engaging manner. In addition, multiple users are represented in the environment simultaneously and so a sense of presence is created within the shared virtual space. Synchronous communication channels allow students and tutors to interact in real time during learning, collaboration and social activities. While CLEV-R is a useful resource for students who have access to a desktop computer, there is now a growing need to facilitate students who cannot be in a fixed location. To cater for these students, we have developed mobile CLEV-R (mCLEV-R), a lightweight version of CLEV-R for use on mobile devices. It provides the same set of communication controls found in the desktop interface which allows users of both to interact. mCLEV-R operates in conjunction with CLEV-R to facilitate mobile learning (m-learning).

The remainder of this paper is organised as follows. Section 2 gives an overview of CLEV-R and presents the main features it provides for learning, socialising and collaborating in a virtual environment. Section 3 outlines the functionality of mCLEV-R describing the features which have been extended to a mobile platform. In Section 4, the techniques employed during a usability study to

ascertain the benefits of both CLEV-R and mCLEV-R are discussed. The results from the evaluations are presented in Section 5 and some concluding comments are provided in Section 6.

2 CLEV-R

CLEV-R builds on existing research in the area of 3D interfaces for e-learning (Bouras et al. 1999, Bouras et al. 2001). In our work we are particularly concerned with addressing the social requirements of students through the addition of unique features which promote social interaction. CLEV-R is presented to users via a webpage. As seen in Figure 1, the interface is split into 2 sections: the 3D Environment and the 2D Communication Interface.

2.1 3D Environment

The 3D environment is a shared virtual world in which each student and tutor is represented by a unique avatar. The environment has multi-user capabilities and thus creates an awareness of the presence of others. Each user controls the location of their avatar within the 3D environment. In addition, each avatar is equipped with gestures such as raising their hand and nodding their head which can be used to visually communicate with others. An example of an avatar can be seen in Figure 1.

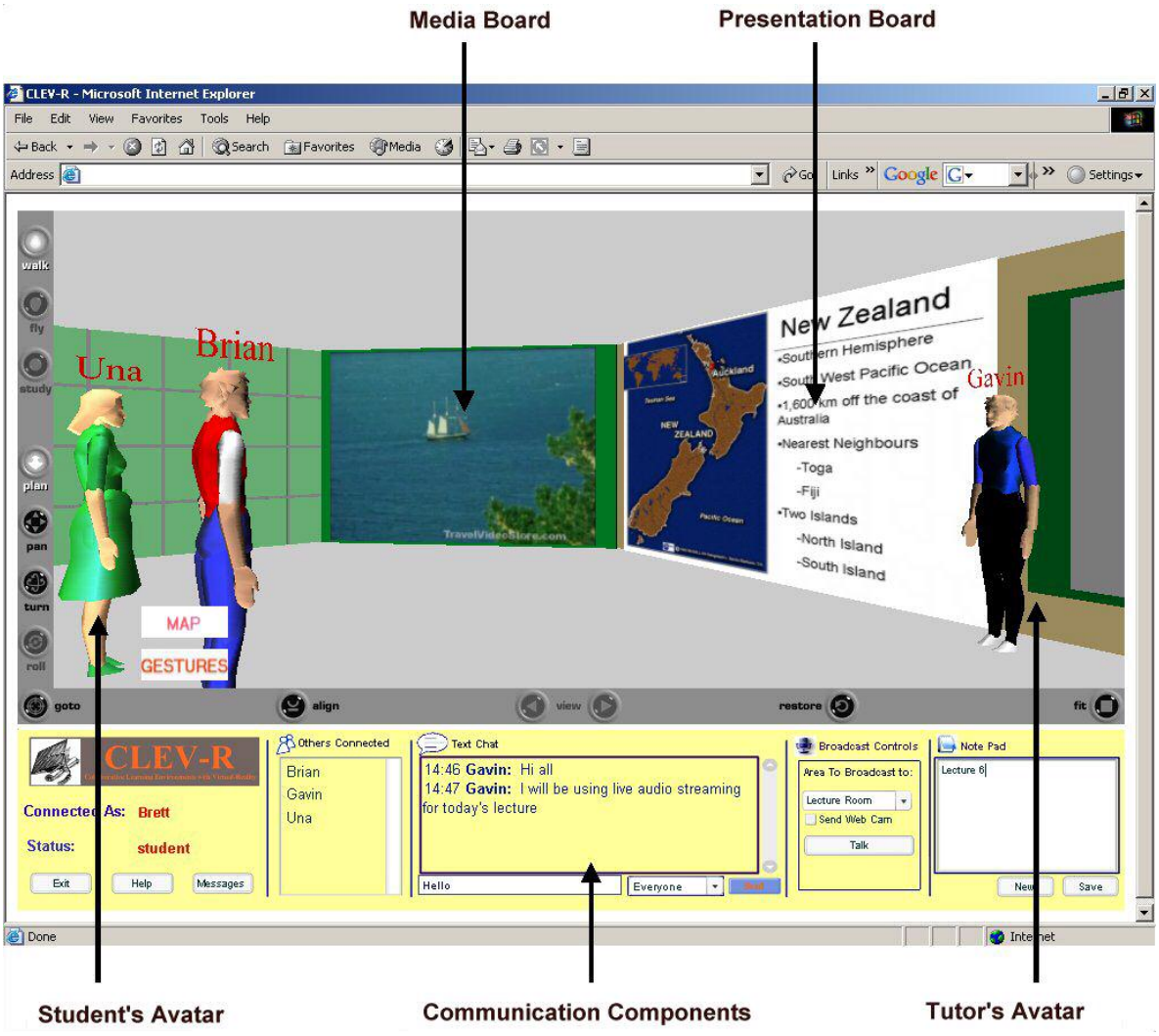

Figure 1: The CLEV-R Interface, Showing a Lecture Taking Place in the Lecture Room

The environment contains a number of rooms which are designed to facilitate specific activities, for example, a *Lecture Room*, a *Library*, *Meeting Rooms* and *Social Areas* are all present. Each room is equipped with tools and facilities appropriate to its function. The virtual *Lecture Room*, shown in Figure 1, can be used by a tutor to deliver live lectures to groups of assembled students. The room contains a large presentation board where the tutor can upload material for the students to view simultaneously. It also contains a media board for presenting movie and audio clips. Tutors can provide live commentary to accompany the lecture content using the audio and webcam communication tools. These facilities are also extended to the *Meeting Rooms.* However, as the focus of this room is to facilitate collaborative tasks such as group projects, the tools in these areas can also be used by students to share presentations and information with each other. As in the *Lecture Room* the communication tools can be used for discussions. The *Library* is an interactive way for students to access, view and download the course notes and additional course information.

Social areas in the 3D environment include a *Common Area*, *Coffee Area* and *Social Rooms*. The *Common Area* can be used by students to interact with each other before and after class. It also contains the *Coffee Area,* where students can chat informally with each other. The *Social Rooms* have similar functionality to the *Meeting Rooms*; presentation and media boards allow students to share photos, music and videos with each other.

2.2 2D Graphical User Interface

The communication functionality provided in the 3D environment is supported by the 2D Graphical User Interface (GUI), which can be seen in Figure 2. While its primary focus is to support the real-time communication aspects of CLEV-R, it also provides some additional and useful resources for students. For example, students can access a text-based help file. There is also a facility for students to take notes and store them for access at a later time via the 3D *Library*. To further enhance user awareness of others, the 2D GUI contains a list of those currently using CLEV-R. There are 3 modes of synchronous communication supported in CLEV-R; text communication, audio streaming and webcam broadcasts.

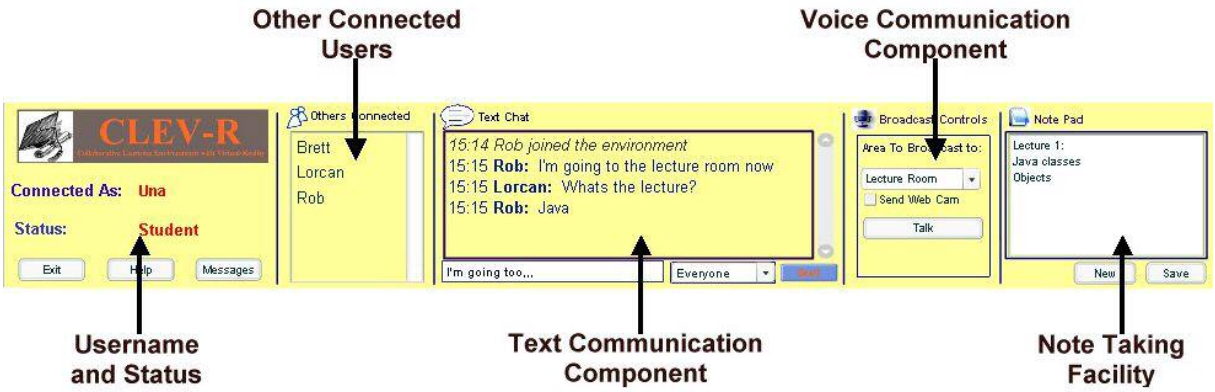

Figure 2: The 2D Graphical User Interface of CLEV-R.

The text communication component of CLEV-R works in a similar way to many of the instant messaging services available on the Internet. Students and tutors can type a short message and transmit it to others. Each text message can be sent publicly to all those currently using CLEV-R, or privately to an individual. The audio streaming component is one of the major strengths of CLEV-R. Users can broadcast a live audio stream from their microphone into a selected area of the 3D environment. Those present in the selected room will automatically hear the broadcast. This facility can also be used to broadcast a live stream from a webcam directly into the 3D environment.

The 2D GUI and the 3D Environment operate in conjunction with each other. A brief description of their functionality has been provided here, but a more in-depth examination of the facilities they provide, along with case studies of the system in use can be found in (McArdle et al. 2007).

3 MCLEV-R

mCLEV-R provides wider access to learning resources by supporting users through mobile devices. The use of mobile devices for delivering learning tools is an area of high interest at present, and much research is currently being conducted in this area (Rekkedal et al. 2005, MOBIlearn 2005, Attewell 2005). mCLEV-R incorporates mobile users into the online learning community which CLEV-R supports. Thus, while it may not be possible for users to be present at a desktop computer for their learning sessions, they can still partake in group learning activities and communicate with others through their mobile device. mCLEV-R has been developed for the Personal Digital Assistant (PDA) platform and is presented to the user through a series of webpages. It consists of 2 main components: the 3D Environment and the Communication Interface.

Figure 3: The 3D interface and Audio Communication Controls of mCLEV-R.

3.1 The 3D Environment

The 3D Environment provided in mCLEV-R is a single room environment which resembles an office. As seen in Figure 3(A), it contains many 3D objects which offer learning services to students. Users can navigate around the environment and interact with these objects using the stylus and touch screen of the PDA devices. Through the facilities it provides, users can download learning material to their device across a wireless network. These files can then be opened using external applications such as Pocket Word, Pocket Adobe Acrobat Reader and Pocket Slides. Access to course announcements is also supported which ensures that users are continually kept up to date regarding developments in their courses, while a link to the Communication Interface enables users to communicate synchronously with each other.

3.2 The Communication Interface

The Communication Interface of mCLEV-R, depicted in Figure 3(B), supports real-time text and audio communication among users. Through these tools students can interact with their course tutor and their peers to partake in group learning activities such as online lectures and group discussions, and to participate in social and informal meetings. These facilities are linked to the text and audio communication features provided in the desktop CLEV-R system, thus mobile users and those connected through the desktop interface can interact with each other. The Communication Interface of mCLEV-R also alerts mobile users to the presence of others and thus plays an important role in creating a sense of social presence for them within a learning community. The text communication feature of mCLEV-R operates similarly to that in the desktop CLEV-R interface. Users can send short text messages to each other and both public and private messages are supported. To utilise the audio communication feature, users select an area to broadcast to. When an area is selected, a list of other users in that location is displayed so that the mobile user is always aware of others that may be listening to their broadcast. The mobile user can then hear broadcasts to this area and can begin their own audio stream to communicate with others. Further details of the functionality provided by mCLEV-R are provided in (Monahan et al. 2007).

4 EVALUATION

An iterative approach was utilised to evaluate CLEV-R and mCLEV-R. Initial evaluations were conducted during the development phase. For example, techniques such as the Cognitive and Pluralistic Walkthroughs (Wharton et al. 1994, Bias 1994) were used to ensure new features incorporated within the system provided the necessary functionality to achieve students' goals. Once the prototype had reached a mature stage a user study was carried out. The purpose of this evaluation was to highlight any usability or technical issues with the systems. Details of this study and its results can be found in (McArdle et al. 2007a). This paper is concerned with detailing the usability testing which was conducted after the problems raised from the first evaluation were resolved. Usability testing (Nielsen 1993) involves studying the interface and its performance under real-world conditions and obtaining feedback from both the system and its users. The usability testing of CLEV-R and mCLEV-R took place simultaneously, thus mobile and desktop users could communicate and interact with each other. This section details the make-up of the participants, describes the tasks they performed and the techniques utilised to obtain and assess their feedback.

4.1 Participants

Table 1 provides a profile of the users that participated in the evaluation studies of CLEV-R and mCLEV-R. The majority of the test-subjects were university students since they are the target users of our online learning interfaces. All users had good to excellent computer skills and most use computers every day.

	CLEV-R	**mCLEV-R**
Total Users	20	12
Males	15	9
Females	5	3
Average Age	26.27	25.6
Previous Experience of E-Learning	12	7
Previous Experience with Mobile Devices	N/A	2
Previous Experience with First-Person Computer Games	9	N/A

Table 1: User Profiles of the Evaluation Participants.

This level of computer literacy among university students is realistic nowadays as the majority use computers frequently throughout their studies. Thus, the sample set is a reasonable representation of the prospective end-users. All participants took on the role of students within CLEV-R and mCLEV-R during the user trials.

4.2 Approach and Procedure

Based on the functionality of the system and an analysis of the common tasks which are required in a learning situation, 3 distinct types of scenario were identified for this evaluation. These involved social, learning and collaboration activities and 4 tasks were devised accordingly.

Task 1 - Social Interaction: The main aim of this task was to introduce the participants to CLEV-R and mCLEV-R and to the facilities they provide. All users participated in an icebreaker game using the text and audio facilities to converse with one another. They also collaborated to decide on a topic for a group project which they would present through the interfaces in Task 3 of the evaluation study.

Task 2 – Learning: This task requested the participants to attend a synchronous online lecture. Interactive lecture material including Microsoft PowerPoint slides, movies and music files was presented to users. The lecturer used the audio communication and webcam features to deliver the learning content and test-subjects were encouraged to contribute. Participants also downloaded the appropriate set of notes for the lecture as part of this task.

Task 3 – Collaboration: In this task, users participated in a group meeting where they presented and discussed the group project chosen in Task 1. Users of the desktop CLEV-R interface were required to upload a Microsoft PowerPoint file to the presentation board in one of the *Meeting Rooms* and use the audio communication facilities to talk about their part of the project. Those using the mCLEV-R interface connected to the audio broadcast for that meeting room to listen to the reports of others and to present their findings. A group discussion on the presented material then took place.

Task 4 - Social Interaction: The final task of the evaluation study was a free session. This task encouraged the participants to socialise with each other and requested users of the desktop CLEV-R interface to share different types of media with one another. It gave the participants free reign with the systems and potentially uncover any usability issues which might arise.

4.3 Evaluation Techniques

A number of questionnaires were administered during and after the user trial. We were particularly interested in feedback regarding the usability and usefulness of the interfaces as well as gauging the test-subjects' attitude towards these new paradigms for e-learning and m-learning. Standard usability questionnaires, combined with some questions specific to CLEV-R and mCLEV-R were used. After each of the 4 tasks outlined above, the After Scenario Questionnaire (ASQ) (Lewis 1991) was administered. This questionnaire consists of 3 statements which examine user satisfaction regarding the ease of completing the task, the time taken to complete the task and the support information available when completing the task. A 7-point likert scale anchored at 1 by Strongly Agree and at 7 by Strongly Disagree is used. The results from these 3 questions can be condensed to give an overall rating of user satisfaction with the interface for completing a specific task. The ASQ was augmented with additional questions regarding the effectiveness of the features provided by the interfaces.

Upon completion of all tasks, Microsoft Product Reaction Cards (MPR) (Benedek & Miner 2002) were utilised to obtain qualitative feedback regarding users' reaction to the systems. This is a tool for determining the desirability of a product or system. It consists of 118 words; approximately 40% of which have negative connotations while the remainder are positive. The user selects as many words as they feel appropriate to describe the interface or system they have just used. As with the ASQ, separate MPR Cards were used for mCLEV-R and CLEV-R.

5 RESULTS AND DISCUSSION

While the evaluation of both CLEV-R and mCLEV-R were carried out simultaneously, feedback regarding each was obtained separately. Firstly, we will examine the evaluation results relating to the desktop system before presenting the feedback regarding the mobile application. The results obtained for each task are first discussed followed by user reactions which were recorded using the MPR Cards.

5.1 CLEV-R

When condensed, the ASQ results for Task 1 give an overall rating of 2.23 on the 7-point likert scale. Along with a standard deviation value of 0.622, this indicates a positive response to the social task with a high level of satisfaction among all test-subjects. As seen in Figure 4(A), additional statements regarding the effectiveness of CLEV-R for this type of social interaction also produced positive feedback. 100% of the participants agreed that the facilities provided were sufficient for this social task, while 90% felt that the CLEV-R interface provides an acceptable means of socialising online.

For the second task, which involved attending a lecture via the virtual *Lecture Room* and accessing course notes from the virtual *Library*, similar positive results were returned. The ASQ results indicate a positive response to this task with an average rating of 2.02 returned, with a standard deviation of 0.82. In particular, 90% of respondents were satisfied with the ease of completing this task, which suggests the usability of the CLEV-R interface is high. As highlighted in Figure 4(B), when asked about the ease of following the lecture, the effectiveness of the communication tools and the acceptability of this as a means of attending a lecture, 95% of participants agreed with each statement. Due to a technical fault with equipment a single user was unable to utilise the communication tools and this accounts for the negative response shown in Figure 4(B).

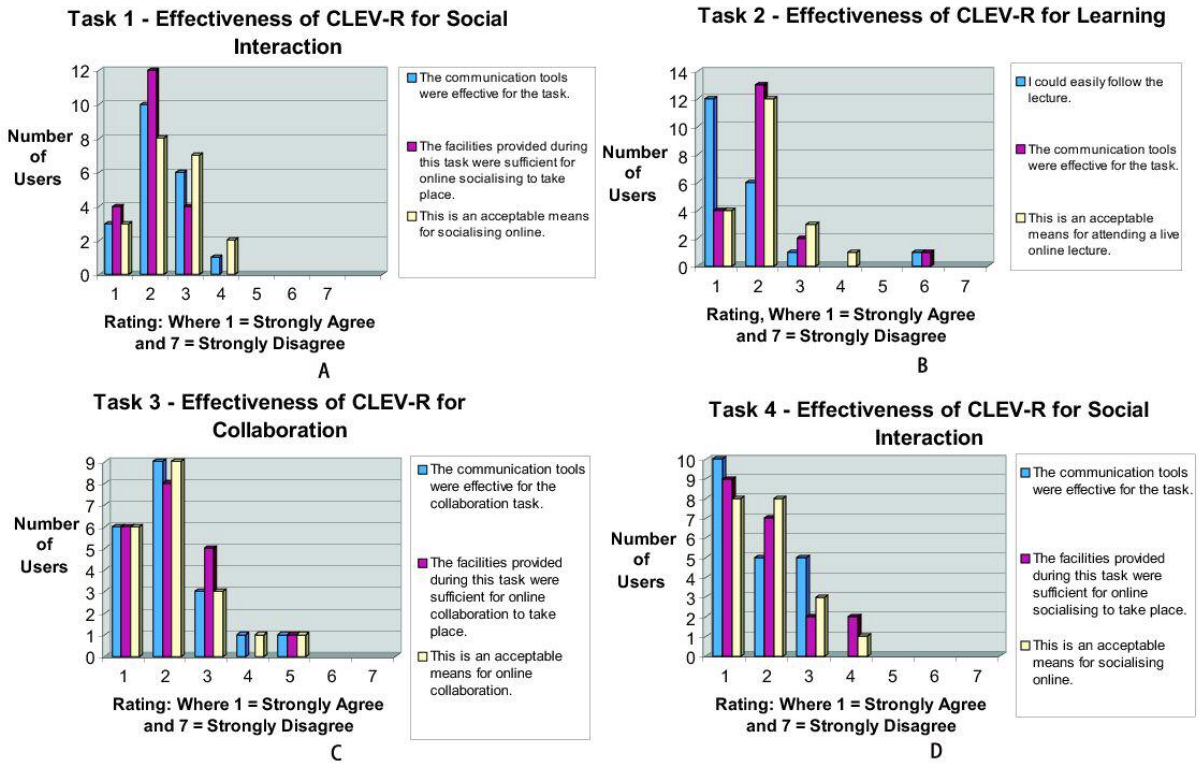

Figure 4: Effectiveness of CLEV-R for each of the 4 tasks.

In Task 3, the test-subjects took part in a collaboration activity. Condensing the results returned from the ASQ for this task gives an overall satisfaction score of 2.03 on the 7-point likert scale, which

shows the majority of participants were satisfied. When asked about the effectiveness of CLEV-R for collaboration similar results were returned. However, as in the previous task and as shown in Figure 4(C), due to technical issues experienced by a single test-subject some negative responses regarding the communication tools for this task were returned. However, overall the majority of participants felt CLEV-R provided an effective means for collaboration to take place and that the tools provided supported this. In addition, 90% felt that CLEV-R offered an acceptable means of collaborating.

As in the initial task, the final one involved social interaction among the participants. The condensed result for the ASQ is 2.15. The ease of use again scored highly with 90% of participants agreeing that it was easy to complete this task. The results regarding the effectiveness of CLEV-R for this task are shown in Figure 4(D). 100% of the test-subjects stated that the communication tools were effective while 95% expressed that the other facilities provided for socialising were sufficient. Again, 95% felt this was an acceptable medium for online socialising.

MPR Cards also formed part of the questionnaires presented to the participants. A selection of the words most frequently selected, is shown in Table 2. In total, 74 unique words were selected by the respondents, of which only 3 had negative connotations. The top ranking words are all positive and we consider them to describe the main objectives of CLEV-R. For example, 'Accessible', 'Collaborative', 'Engaging', and 'Fun' were ranked within the top 5 responses. The selection of primarily positive words reinforces the participants' positive attitudes towards CLEV-R which was returned from the ASQ element of the evaluation study.

Word	**No. of Responses**	**Word**	**No. of Responses**
Accessible	**14**	Fun	**9**
Collaborative	**12**	Effective	**8**
Engaging	**12**	Efficient	**8**
Usable	**10**	Easy to use	**8**

Table 2: Words Frequently Returned by Users in the MPR Cards.

Figure 5(A) shows a graph summarising the condensed ASQ scores for each of the 4 tasks. Overall the satisfaction level of the test-subjects was consistently high indicating that CLEV-R appealed to users for each of the learning, collaboration and social scenarios. It is important that interfaces are usable; the tools provided for CLEV-R were continually cited as easy-to-use during the usability study. This is supported by the positive responses returned for the effectiveness of the facilities provided.

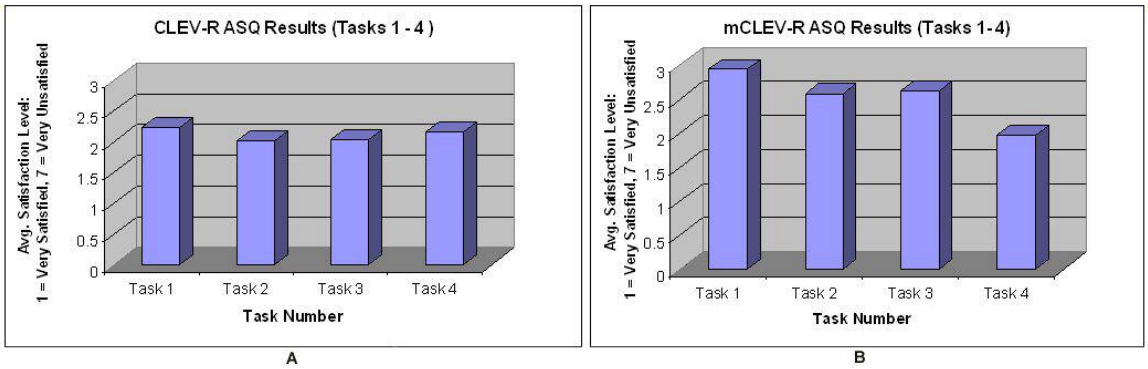

Figure 5: ASQ Results for CLEV-R and mCLEV-R.

The feedback obtained via the MPR Cards also indicates the test-subjects enjoyed interacting with and using CLEV-R. Results from the other elements of the CLEV-R usability study also show that it appealed to test-subjects and that they found it more favourable than existing e-learning systems. Combining this with the results presented here indicates that this paradigm for e-learning, which includes features to support social interaction and collaboration, has a great deal to offer students.

5.2 MCLEV-R

An average ASQ satisfaction rating of 2.943 on a 7-point likert scale was received for Task 1 of the mCLEV-R user evaluations. While this is a positive result, a high standard deviation of 1.495 showed that user reaction varied considerably. Further feedback in relation to this task is displayed in Figure 6(A). As shown, the majority of users (75%) found the communication methods effective for participating in the task and thought the mCLEV-R environment is an acceptable means of partaking in social interaction when it is not possible to use a desktop computer. However, 2 users took part in an evaluation session during which some delays with the wireless network occurred. This, together with difficulties inputting text using the virtual keyboard and stylus of the PDA, which some users experienced, accounts for the negative responses returned.

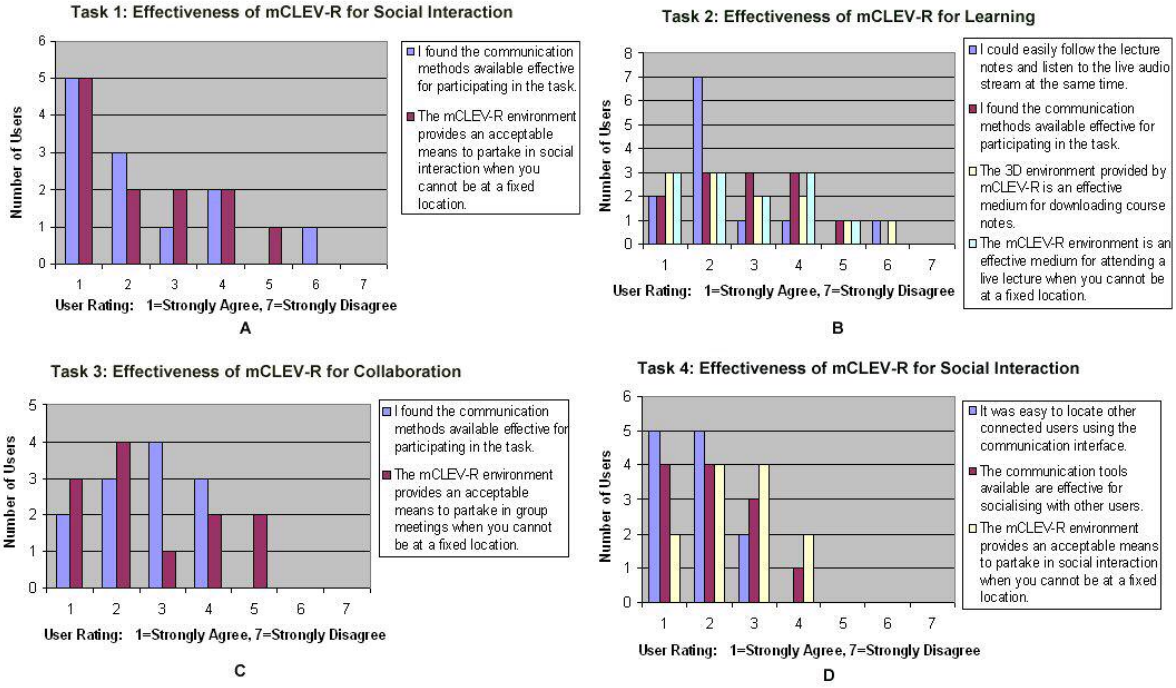

Figure 6: Effectiveness of mCLEV-R for each of the 4 Tasks.

All users successfully took part in the online lecture task by downloading course material and listening to the tutor's audio broadcast. Results displayed in Figure 6(B) show that 83.33% of users found it easy to follow the lecture slides and listen to the audio commentary simultaneously, while 66.66% of users found the communication methods effective for participating in the task. The main difficulty experienced by users was navigating between different applications to view lecture material and access the communication facilities. Screen size of PDAs is a severe limitation on the amount of information that can be displayed at any one time. It is thus not possible to provide the functionality of mCLEV-R without alternating between different applications. This task received an average ASQ satisfaction score of 2.58 with a standard deviation of 1.217. Thus, while some found navigating on the PDA difficult, the overall response to the system for this task was positive.

Task 3 of the mCLEV-R evaluation scored a positive average ASQ satisfaction value of 2.62. The communication facilities are imperative for this task and as displayed in Figure 6(C), 75% of the participants felt that they were effective for taking part in this activity. 66.66% of users agreed that mCLEV-R provides an acceptable means of partaking in group meetings when it is not possible to be in a fixed location. The 33.33% that rated this question as a 4 or 5 on the 7-point scale highlighted the inability to view files uploaded by other students as a disadvantage in this learning scenario.

The final task was rated very positively. It received an overall satisfaction ASQ scoring of 1.97 and a standard deviation of 0.937. While one user did highlight the inability to share music and videos with others, the majority of users, as seen in Figure 6(D), believed that mCLEV-R provides sufficient tools for socialising. They all located other users successfully and communicated with each other.

Overall user reaction of mCLEV-R was recorded using the MPR Cards. 84 out of the 118 words were selected to describe mCLEV-R, 74 (88%) of which were positive and 10 (12%) were negative. The top 26 words which occurred 4 or more times are all positive and included 'Useful', 'Collaborative', 'Creative' and 'Fun' which are all very encouraging. The negative words on the other hand had a much lower occurrence which indicates that overall users were satisfied with the features mCLEV-R provides. Table 3 shows some of the most frequently occurring words returned by users.

Word	**No. of Responses**	**Word**	**No. of Responses**
Useful	9	Novel	6
Collaborative	7	Valuable	6
Creative	7	Appealing	5
Fun	7	Easy to use	5
Convenient	6	Effective	5

Table 3: Words Frequently Returned by Users in the MPR Cards.

The results from this evaluation study show that users were satisfied with the functionality that mCLEV-R provides for learning, socialising and collaborating online through mobile devices. The average ASQ ratings obtained for each of the 4 tasks, which are summarised in Figure 5(B), were positive and further feedback indicated that users found the tools provided in mCLEV-R effective for participating in the various learning scenarios. The results received from the MPR Cards were similarly positive and show that the participants enjoyed using the m-learning interface and found it appealing. Overall, the results are very encouraging and suggest that the functionality provided by mCLEV-R is beneficial for m-learning. Access to learning material while on the move is in itself an extremely useful feature; however, when coupled with support for synchronous communication, the benefits increase significantly. M-learning no longer needs to be a solitary activity. Instead users can become part of an online learning community and participate in group activities with their peers.

6 CONCLUSION

The use of information systems is becoming more prevalent in everyday life. This is particularly evident within the area of online learning. A number of systems have been developed which offer a mechanism for students to access learning content using the Internet. Although there is an increase in the use of such systems, studies indicate that courses which are run solely using such techniques have problems retaining students. Boredom and lack of interaction are cited as contributing factors to the high dropout rates witnessed in such courses. To address this, we have developed a new type of GUI for accessing e-learning content. Within our system, CLEV-R, learning material is accessed via an onscreen 3D environment, which ensures students are engaged. Real-time communication techniques allow instant interaction between students and tutors. Such communication not only permits synchronous lectures, but can also be extended for use as a tool for collaborating and socialising. The communication-rich 3D environment for e-learning is extended for use on mobile devices through the development of mCLEV-R. This lightweight version of CLEV-R features a tailored 3D environment for accessing lecture material and a set of real-time communication tools which enable those using mobile devices to listen to lectures and interact with the users of the desktop interface. CLEV-R and mCLEV-R were evaluated simultaneously. Four tasks were devised which ensured the test-subjects experienced the various components of the interfaces. The ASQ, which gauges participants' satisfaction with a particular task returned an overall positive result. Users were satisfied with the tools and features provided for each of the tasks. Microsoft Product Reaction Cards also returned primarily positive feedback. The findings from the usability studies indicate that both CLEV-R and

mCLEV-R appeal to students and a 3D online learning environment, accompanied by synchronous communication facilities, has much to offer e-learning and m-learning. Furthermore the paradigm can be extended to other domains such as e-commerce and data management to provide an interactive mechanism for accessing and processing information. While the results presented here, are very positive, a comparison study with other e-learning systems could add further weight to the benefits which CLEV-R and mCLEV-R can bring and would be an interesting area of further research.

Acknowledgement: The support of Science Foundation Ireland under the National Development Plan and Strategy for Science Technology & Innovation 2006-2013 is gratefully acknowledged.

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