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An angel on my shoulder: Mimicking face-to-face supervision of computer-based experiential learning over a local-area-network

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Abstract-Irrespective of the methods used for its delivery, interactions or conversations with an instructor should always be the core of education. In the case study reported here the suitability of a commercially available classroom management tool, with built-in bi-directional audio communication and a range of computer application-sharing services, was explored for the supervision of online students who were performing computer-based experiential learning. Event recordings and practitioner reflections were used to triangulate the outcomes. Analyses of the data collected during this study showed that software utilities that support network-based audio communication and remote computer-desktop control enable the online mimicking of pedagogy that can be identified during face-to-face supervision of this style of learning. The findings of this research can facilitate the implementation of wide-area network-based education platforms that will enable the real-time online supervision of students performing learning-by-doing. The importance of such applications for distance educators has been articulated by those educationalists who have identified the successful delivery of laboratory content within their science-based curricula as one of the distance education providers’ greatest challenges.

INTRODUCTION

The provision of student access to hands-on experimentation for technology-based coursework is equally important whether it is delivered face-to-face or online [1]. With the growth of online education, the need exists for new and innovative ways to achieve the interactive environment that is necessary for quality outcomes [1], particularly the facilitation of laboratory experimentation by distance learners [2]. While the common advantage cited for both remote and virtual laboratories is the unrestricted access that is inherent in their current implementations, the presence of an expert mentor is critical and “will have a substantial effect upon the learning experience above and beyond that of changing access mode” [3: 621]. The suggestion that asynchronous communication, such as e-mail, may have the desired benefits of face-to-face conversation is a contentious one [4]. Conversely, researchers have confirmed that synchronous remote support of such learners with the application of computer-desktop sharing and video-chat can be as effective as if the supervisor was collocated with the students [5].

Other researchers have described good teaching as a conversation [6, 7] or as an interactive engagement with the students [8-10]. Laurillard [11] re-interpreted her original concept, commonly known as the Conversational Framework, for educational scenarios that employed a variety of recent technologies, such as video, DVD, web resources, simulations, etc. The facilitation of such conversations for off-campus students, who are participating in learning-by-doing within science-based curricula, has been identified as one of the distance education providers’ greatest challenges [12, 13]. During the supervision of laboratory experimentation or problem-solving tutorials extensive participant interactions must occur. As shown in Fig. 1, Laurillard’s [11] Conversational Framework has been adapted by Ling [14] in order to illustrate this style of teaching/learning.

In the context of distance education the quality of the practiced pedagogy is purely a function of the applied communication technologies. Investigations into the application of interactive electronic media have shown that synchronous rather than asynchronous communication resembles face-to-face environments [15]. The importance of audio bandwidth was highlighted by Martarazzo and Sellen [16] who found that speed rather than quality of synchronous communication resulted in more efficiency and satisfaction with non-proximal collaborators.

Additionally, in academia higher interaction levels have been perceived when instructors responded faster with feedback to any student-initiated questions. [17]. While the
transmission of facial expressions and body language require a video link, any thumbnail-sized ‘talking head’, occupying potentially valuable computer-screen real estate, has been found to be of little ultimate benefit, since the image size of the participants, as well as the possible delays in any accompanying audio has a strong effect on the naturalness of the resultant conversation [18]. Other research has also confirmed that shared computer desktops have been extremely valuable for distributed online collaboration [18].

THE CASE STUDY

In 2007 a case study was mounted to investigate the application of online synchronous communication for the supervision of students who were performing computer-screen-based tutorial exercises in an introductory subject dealing with electronic circuit behavior that was part of all engineering degree courses offered at Swinburne University of Technology. At the start of that academic year, without being aware of this research project, all prospective students were instructed through an online portal to register their selection for attending one of seventeen timetabled tutorial groups for this subject. At the beginning of the second teaching semester the researcher selected two of these groups to tutor. This selection was based only on the availability, at the already-scheduled tutorial timeslots, of both the researcher and a specific computer laboratory on whose desktop computers copies of the software required for the research were installed. In this way, the student participants were selected in a pseudo-random fashion.

In each of the tutorial sessions, the students were scheduled to complete a number of problem-solving exercises. In order to ensure that the student used the laboratory computers, the researcher integrated the electronics circuit simulation software, Electronics Workbench™ Multisim 2001 Text Book Edition (Prentice Hall, New Jersey, USA), into his delivery of the curriculum. Consequently, in these two tutorial classes, the students were required to initially simulate electronic circuits on a computer screen, take appropriate measurements of voltages, currents, waveforms, etc., and then mathematically verify their results; or alternatively once their calculations were complete verify these with appropriate simulations. Earlier research has found that student use of this software in the study of electronic circuit theorems encourages deeper levels of learning [19] – making the introduction of this tutoring approach an ethically acceptable alternative.

Throughout the semester a total of sixteen tutorial sessions were delivered by the researcher - nine supervised face-to-face and seven online. As shown in Fig. 2, with the aid of a commercially available classroom management tool, NetSupport School (NetSupport Inc., Peterborough, UK), the students’ on-screen activities were remotely supervised over the University’s local-area network (LAN). During each of the tutorial classes, the supervision of the students’ computer-screen-based activities was either face-to-face or online, and was varied week-by-week and group-by-group. The numbers of students who attended these tutorials also varied from week-to-week and from group-to-group.

The data collection process from the tutorial sessions employed a three-layered interpretive model for media-rich research into social interaction that is underpinned by the ‘event matrix’ and consists of: the ‘raw data layer’, the ‘observed events layer’ and the ‘analysis layer’ [20].

For the face-to-face supervised tutorials, the verbal interaction that occurred (the ‘event matrix’) was recorded on a portable audio recorder (the ‘raw data layer’) by clipping a lapel-microphone to the academic. These recordings were transcribed into ‘storyboards’ (the ‘observed events layer’) with the subsequent addition of time stamps and the corresponding images from the Microsoft® PowerPoint® slide shows which were used to pace the students’ activities during each tutorial class.

For the online, supervised classes, each student’s computer screen activities (the ‘event matrix’) were recorded using the appropriate in-built feature of NetSupport School (the ‘raw data layer’). NetSupport School’s feature of bi-directional audio communication over the local-area network was utilised to facilitate discussion between the participants who were wearing personal microphone-headsets during these tutorials. Later, these recordings were converted into video files (the ‘observed events layer’).

As soon as practicable after the conclusion of each tutorial session, the researcher also documented for later analyses his reflections on the aims, delivery, and success of either the face-to-face or the online supervision of the participating students’ activities.

RESULTS AND ANALYSIS

Recordings and the academic’s post-event reflective journal entries of both face-to-face and online supervised tutorials were analysed for the presence of experiential learning supervision pedagogies, as listed in Table I. These were summarized in four matrices as binary data; that is by
placing an ‘X’ in a cell to indicate the identification of the corresponding item, while an empty cell represented its absence. There was no attempt made to indicate the intensity and or quality of the items identified in this way.

A visual inspection of the columns clearly indicated that there were minimal differences between the identified activities and pedagogies for the recorded face-to-face and online supervised tutorial sessions. A similar conclusion was drawn from examining the academic’s recollections of the events as described in the entries of the post-event reflective journal. In line with the findings of O’Keefe et al [21] such differences may be accounted for by the degree of difficulty of the given tasks and/or the needs of the students who were performing these rather than by any limitations of the employed technology. The results also indicated that Laurillard’s Conversational Framework processes, as detailed in Fig. 1 were achieved in both supervisory modes.

The binary data obtained for the activities and pedagogies for the 16 tutorial sessions were statistically analyzed for any significant differences between the two supervision modes practiced during the study.

A cross-tabulation is conventionally performed in order to explore the relationship between two categorical variables that result from binomially-classified objects [22]. Since the sample size in this case was small (n=16), the practical significance of any obtained statistical result has to be limited [23]. In an attempt to minimize this potential drawback, Fisher’s Exact Test (2-sided) was identified as the most appropriate statistic for tables of data with such small frequencies.

The significance probability $p$ value for Fisher’s Exact Test (2-sided) is the probability of obtaining, by chance, an observed difference (in either direction) that is the same as or more extreme than actually observed in the data which has no real or underlying difference. Thus, the smaller the $p$ value, the more convincing is the evidence of this difference. The tests were carried out at the 0.05 level, meaning that the conclusion of a real difference may only be drawn if the obtained $p$ value is less than 0.05. It is worth reiterating that this test does not indicate the magnitude, the importance or the significance (in the common meaning of this word) of the difference between the compared data. The statistical software SPSS Statistics 17 for Windows® (SPSS Inc., Chicago, IL.) was used to generate the cross-tabulations and to calculate the respective probabilities that are summarised in Table I.

A visual inspection of the second right-most column of Table I (headed ‘Obs’ and obtained from the recordings) indicates a calculated $p >0.3$ for each case. Also, a visual inspection of the right-most column of Table I (headed ‘Jnl’ and obtained from the reflective journal entries) indicates a calculated $p >0.438$ in each case. Since all of these $p$ values are much greater than 0.05, the null hypothesis of no difference between the practiced face-to-face and online supervision using NetSupport School or a similar software utility is retained in each case - consistent with no overall difference between the supervisory methods. In order to decrease the chance of incorrectly concluding that no difference exists, investigations with larger numbers of participants would be required. Testing in different teaching contexts would also be valuable.

### CONCLUSIONS

During this case study, NetSupport School clearly enabled the supervising academic to easily and promptly encourage, via the audio link, individual student contributions and frequently identify the need for any potential guidance by remotely monitoring the students’ computer screens and, if necessary, control their keyboards and mice to demonstrate as well as explain any necessary processes.

In other words, some elements of face-to-face pedagogy can be mimicked online with communication software, like NetSupport School, which has features that facilitate the following:

- real-time voice and optional visual contact between all participants,
- one-to-one sharing of computer desktops and applications,
- the capacity for graphics-based interaction, in order to annotate any participant’s desktop,
- a means for learners to indicate that they have questions, or are confused,
- applications for assessing student moods, opinions, comprehension and for soliciting questions or feedback,
• the ability for many-to-one sharing of computer desktops in order to view all learners’ activities in real-time.

There is no suggestion that this form of distance education should become mandatory. However, it should be an integral part of the repertoire of teaching tools that are available for the online supervision of experiential learners.

While the case study was conducted over a LAN, there is every reason to expect that in the long term the results obtained will be the same for a wide-area network (WAN) implementation, such as the Internet – for which the network topology is shown in Fig. 3. Currently, two limitations exist for achieving this - namely the availability of a single commercial software with the features of NetSupport School that is designed for use over the Internet, and the current hardware limitations (in particular bandwidth and latency) of most Internet connections. Fortunately, due to the worldwide requirement for collaboration software and high-speed communication, technology providers are endeavoring to resolve both these issues as quickly as possible.

The implementation of systems, like the one used for this study, that facilitate the mimicking of some face-to-face pedagogy during the online supervision of experiential learning is simply a recognition of the fact that fundamentally distance education is just education at a distance [24] – not in the least in engineering education.

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