RESEARCH ARTICLE

Perceptions of online tutorials for distance learning in mathematics and computing

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We report on student and staff perceptions of synchronous online teaching and learning sessions in mathematics and computing. The study is based on two surveys of students and tutors conducted 5 years apart, and focusses on the educational experience as well as societal and accessibility dimensions. Key conclusions are that both staff and students value online sessions, to supplement face-to-face sessions, mainly for their convenience, but interaction within the sessions is limited. Students find the recording of sessions particularly helpful in their studies.

Keywords: eLearning; eTutorials; synchronous online learning; STEM

Introduction

Mathematics and computing educators have long understood the importance of active student participation to facilitate deep learning of core ideas and techniques. For part-time distance-learning students studying with the UK's Open University, the traditional teaching medium has been highly structured, professionally produced notes and support from an individual tutor, specifically feedback on tutor-marked assignments and face-to-face tutorials. The latter have provided an important means of student support, but some students find it hard to attend because of work and social commitments. Students with additional requirements, those residing far from tutorial venues, overseas students, and those with family commitments have found it particularly challenging to attend face-to-face events. These problems have naturally led to the growth of online teaching, which provides its own challenges for symbolically-rich disciplines.

Over the last 25 years, there has been significant research in distance learning and, since the Internet era, in eLearning, both as a component of distance education and as a significant research field in its own right (Moore 2013; Zawacki-Richter and Anderson 2014). According to Moore's model of distance education, transactional distance (a function of course structure, dialogue and learner autonomy) is a key factor in students' learning (Moore 2013, Chapter 5). Consequently, effective distance-learning course design should reduce or mitigate the effects of transactional distance. As reported by McBrien, Jones, and Cheng (2009) in their study at the

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University of South Florida, virtual classrooms have been found to have a positive effect on each of the three key components of transactional distance.

Other studies of synchronous learning tools have tested the community of enquiry framework (Garrison, Anderson, and Archer 1999). For example, Ling (2007) studied Organisational Informatics tutorials conducted in online chat-rooms at Murdoch University. She found evidence of all three elements of the model, which are (Evans and Haughey 2014): 'teaching presence (instructional activities required to facilitate learning), social presence (activities that support discussion and dialogue for learning), and cognitive presence (the learning resulting from the interactions in the community)'.

Other research has focussed less on theoretical models underpinning distance education. Kear *et al.* (2012) report on online conferencing for the Open University module *Networked Living: Exploring Information and Communication Technologies.* Their work follows on from earlier studies by Chetwynd *et al.* (2009), Lissaman, de Pomerai, and Tripconey (2009), Loch and McDonald (2007), Mestel *et al.* (2011), Ng (2007), and Reushle and Loch (2008).

In the context of mathematics, computing and other STEM (Science, Technology, Engineering and Mathematics) disciplines, building a community of enquiry and/or reducing or mitigating the effects of transactional distance are complicated by discipline-specific requirements: interactive presentation of visual images, symbolically-rich notation, complex calculations, either by hand or through software packages, and even scientific experiments.

Many STEM educators have enthusiastically embraced the opportunities provided by the Internet, despite their clear challenges. Since 2009 the Open University has used an education-oriented synchronous communication tool, sometimes known as a virtual classroom. Consequently, a significant amount of experience and knowledge on the use of this medium has accumulated, from both the student and tutor perspectives. This study aims to capitalize on this wealth of experience to investigate whether familiarity with such systems has changed attitudes towards their use by considering the following research questions:

(1) Have tutor and student attitudes to the use of virtual classrooms changed over the 5 years since their introduction, and if so, how?
(2) Has the use of virtual classrooms reduced or mitigated the transactional distance in distance education and helped build a community of enquiry, especially for disabled students?
(3) What are student/tutor attitudes to the recording of online sessions?

Background and methodology

The Open University (OU) is the UK's premier distance-learning university, with around 170,000 mainly part-time students, studying courses ranging from preparatory access modules to masters and beyond. It has a world-wide reputation based on its blended open learning methodology, combining quality learning material (both printed and online), correspondence tuition, and online and face-to-face support provided by a network of approximately 6,000 tutors. Since its early days it has continually updated its teaching and learning to incorporate technological developments, including full use of the Internet to deliver both asynchronous and synchronous learning opportunities.

In 2008–2009, as part of a project to investigate the possibilities offered by the Internet to enhance the distance learning of mathematics, the authors conducted a trial of synchronous online tutorials using the Elluminate *Live!* software system (Mestel *et al*. 2011). The trial covered principally mathematics, but also some computer science, technology and science modules. Subsequently, the OU adopted Elluminate *Live!* as its platform for synchronous online teaching. When the software was merged into Blackboard Collaborate, the OU adopted the revised product.

The current study combines the 2008 survey with a further survey conducted in 2014, and focusses on student and tutor perceptions of synchronous online learning events within STEM higher education, principally mathematics, and how these have changed during the first 5 years of use.

Although the specific names of the software systems used were mentioned in the surveys (since they were familiar to tutors and students), here we refer to the sessions conducted in the virtual classrooms provided by these systems as 'eSessions'. There are technical and aesthetic differences between the different versions of the software used, and between other products providing similar functionality. The main technical improvement in the software used over the period of this study was related to the transmission of audio, and in particular reductions to both delay and echo. The aesthetic differences between Elluminate *Live!* and Blackboard Collaborate are illustrated in Figure 1 and mainly relate to styling and icons. For this study, however, it is the underlying functionality of the products to facilitate online teaching and learning which is the focus, and this is not specific to the particular software system.

The 2008 trial and survey comprised 29 tutors conducting eSessions. After each event, all the participants (students and tutors) were asked to rate the eSession both from a technical standpoint, and as a learning experience. At the end of the trial, each participant was asked to complete a survey that addressed wider questions including societal and accessibility dimensions. The trial largely focussed on perceptions of technical features of the environment used and student and staff perspectives of these aspects were reported by Mestel *et al*. (2011). All tutors in the trial were self-selecting and were paid a fee for their participation. Only the students of the participating tutors were invited to participate in the 2008 trial.

In 2014 most tutors who participated in the 2008 trial had continued to hold eSessions throughout the 5 year period, and were willing to share their perspectives: 21 of the original 29 participated on a voluntary, unpaid basis. Since students are assigned to a tutor for only a single module, and students have many varied study pathways, it was not possible to poll the same students in 2014 as in 2008. Instead
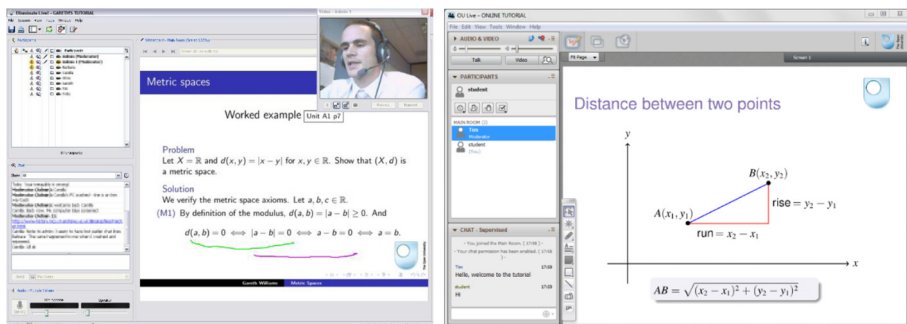

Figure 1.   The Elluminate *Live!* (left) and Blackboard Collaborate (right) user-interfaces.

student participation was solicited via an open invitation in module online forums. Consequently care must be taken when comparing the results in the two studies.

In both surveys, participants were asked to rate aspects of the system and their learning experience on a five-point Likert scale (with 1 the most negative, 3 neutral, 5 the most positive) and given the opportunity to provide free-form comments. The 2008 survey included questions regarding participants' Internet connection and provider, and specific questions on audio quality (which was a particular concern at the time) which were not included in the 2014 survey. The surveys did not consider demographic information on students, their previous background or study intentions.

Headline results

In 2014, 16 responding students reported non-participation in eSessions, due to a lack of: awareness, interest, Internet access, and confidence in the software, as well as the limited number of eSessions offered and a preference for face-to-face tutorials. Two students indicated that they had accessed recordings but had not attended a live eSession. Anecdotal evidence suggests that there is a significant group of students in this category.

In total 106 student participants provided feedback on their experiences (three students provided no feedback). Over 80 modules were covered; these were principally mathematics, mathematics education, computing, science and technology, but also included a small number of business and languages modules.

Of the different types of eSession attended by students, tutorial sessions (eTutorials) formed the bulk, with eLectures also featuring strongly. Interestingly, students did not report using virtual classrooms for self-help groups and few have had one-to-one individual support (eSupport) sessions with a tutor.

Figure 2 shows the responses, from both surveys, for the perceived effectiveness of several features of the virtual classroom in supporting learning. Note that in the 2008 survey, students and tutors rated the features after each individual eSession, leading to higher overall response numbers. The figure shows a diverging stacked bar chart [following Robbins and Heiberger (2011)] with neutral responses centred on zero, positive responses on the right, and negative responses on the left. It shows widespread agreement between staff and students in 2008 and 2014. Interestingly, the student perception of text-chat to help learning decreased slightly between the surveys, despite anecdotal reports that it is widely used. Perhaps multiple simultaneous conversations on many topics, not all entirely related to the teaching aim of the session, contribute to this. Staff perceptions of the effectiveness of application sharing increases slightly over the study period, perhaps as they became more familiar with the possibilities it offers, whilst students' perceptions decreased. Both staff and student views on the effectiveness of breakout rooms and webcams decreased over the period of study. These conclusions must, however, be viewed in the light of the smaller number of responses in 2014.

Comparison with face-to-face tuition

To understand student and tutor views on eSessions compared to traditional face-to-face teaching, there were several questions in the survey to test opinion on the 'learning experience' (Figure 3). Although this term was not explicitly defined in the surveys, we take it to be a holistic view of the effectiveness of the eSessions for
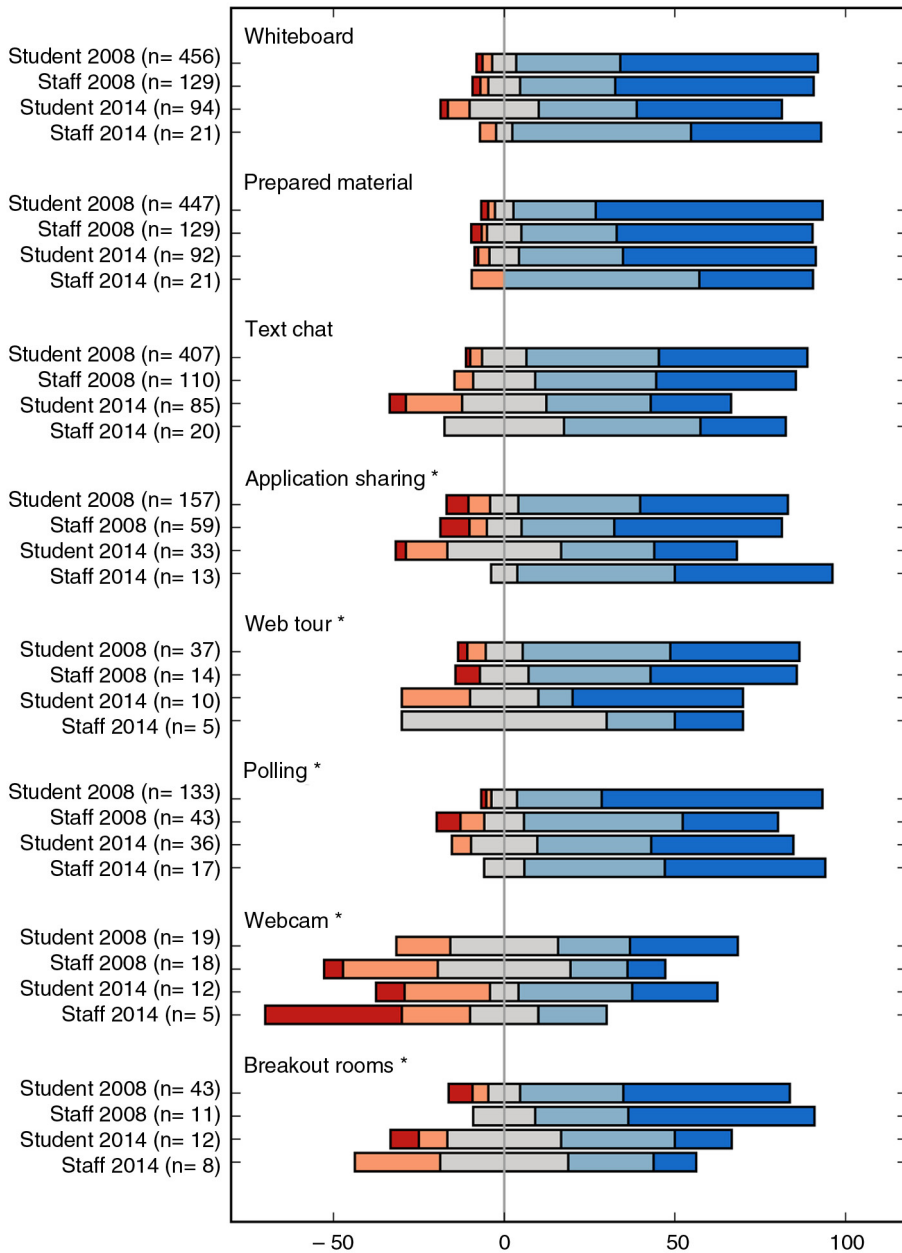
Figure 2. Responses on a five-point Likert scale for perceived effectiveness of various aspects of the virtual classroom. Items marked * were not used in all sessions, and data were only collected for sessions in which they were used.

teaching and learning, be that transfer of knowledge or academic discourse. It is apparent that there is widespread consistency between staff and students, and across the 2008 and 2014 surveys. eSessions are highly rated for the overall learning experience, although there is a slight decrease in the rating given by students between the two surveys. This may be due to heightened student expectations as a result of
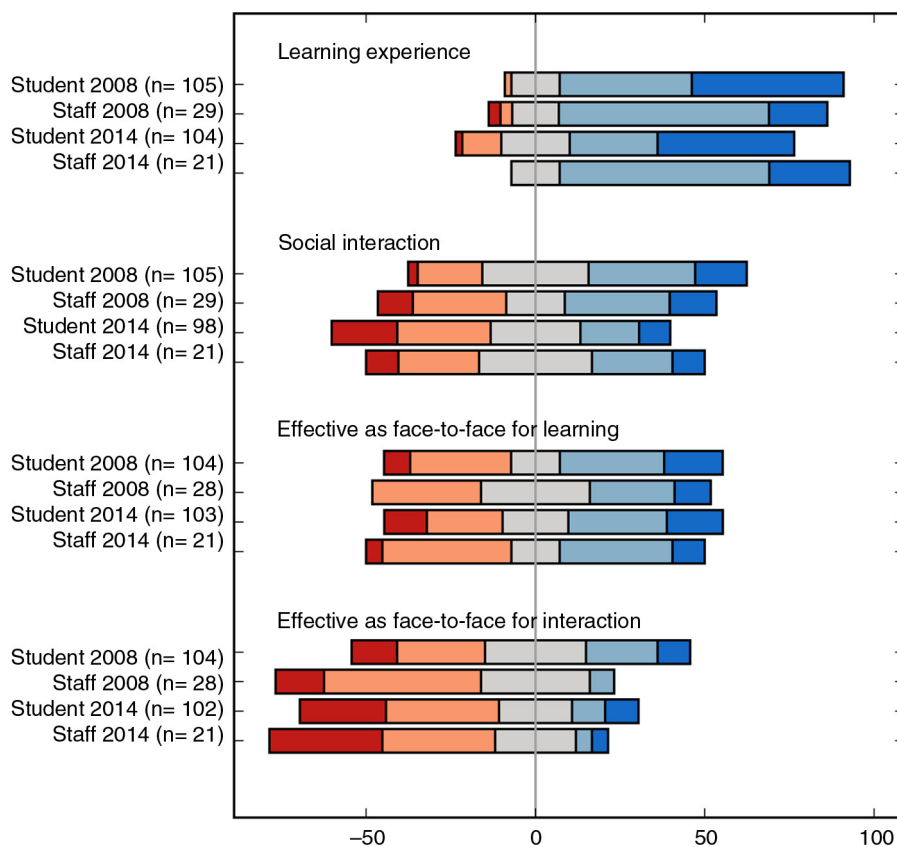
Figure 3. Evaluation of eSessions over several criteria, including comparison with face-to-face, interaction and overall learning experience.

changes to higher education in the UK between 2008 and 2014. There is a very small overall view that eSessions are as effective for learning as face-to-face teaching, but eSessions rate poorly for interaction compared to face-to-face sessions from both students and staff. Within the virtual classroom, interaction could take place between students and tutor or amongst students using text or audio communication, on the shared whiteboard or within a shared application. Once again, student rating on this have slightly decreased over the study period. This relative low score is somewhat concerning, especially from the perspectives of the community of enquiry and transactional distance frameworks. Despite this, overall views on interaction of a social nature within eSessions were neutral.

Interaction in general also featured as a strong theme in open comments by students and tutors, with both positive and negative experiences. Negative comments included:

It is rather passive (little interaction).
Lack of/quality of interaction with other students (there is some but not a huge amount).
Almost impossible to interact and ask effective questions. The tutor is unable to read the mood of the group and judge pace and content. With no face-to-face tutorials in[ter]action with fellow students massively reduced.

One student commented:

> These sessions are no substitute at all for face-to-face teaching. Interaction is stilted and slow, particular[ly] with many participants. In general, 'tutorials' tend to become lectures. Of course, this can happen in face-to-face settings as well, but the nature of the medium makes it harder to avoid with online presentation.

On the other hand, there were significant positive comments on interaction amongst students: 'I like the real time interaction with my classmates . . . and tutor'.

Some thought eSessions compared favourably with other modes of communication: 'Better way to meet/chat to other students and tutor than in [asynchronous] forums', and liked 'interaction and asking questions without having to take time to try and annotate it in an email to our tutor'. Another commented: 'I like being put on the spot with poll questions and getting that instant feedback', and noted that 'My course . . . is very solitary (which mostly suits me) but I do like the little bit of live interaction that I get in these sessions with my fellow students primarily in the IM [Instant Messenger] section'. It is not surprising that those students who do not have access to face-to-face tutorials (as in the MSc in mathematics programme) welcome the interaction that eSessions provide, while those with face-to-face opportunities were more circumspect.

Staff comments were similarly mixed. 'I enjoy taking online tutorials and have much bigger numbers attending than at face-to-face tutorials. But I don't think that online tutorials will ever replace the magic of a good face-to-face tutorial where interaction, group work and individual contact with students are all easier'. Another remarked:

> One of the most difficult aspects for me has been encouraging students to interact with the session – this is much easier in a face-to-face session. This extends to the fact that as a tutor, you have no visual clues to how students are reacting to the content being covered, and other techniques need to be used to try and gauge this, i.e. polling.

Some students commented on the specific difficulties in using the system with mathematics and scientific subjects, in particular the difficulty in writing equations, the fact it is hard to write neatly on the whiteboard without specialist equipment, and the restrictions imposed by the size of the whiteboard. Similar difficulties are not unknown in face-to-face teaching.

Societal and accessibility dimensions
Convenience and optimal times
Figure 4 shows the staff and student responses for questions relating to convenience and efficiency of eSessions. There is a slight decrease in convenience over time reported by both staff and students. In regard to efficiency, there is a slight decrease in the ratings given by students between the two surveys, and a slight increase in the tutors' ratings.

Staff and student comments highlighted the convenience of the medium. As one student put it: 'No need to travel/able to get to tutorials that I could not travel to; saving time and money'. For some, eSessions are the only option: 'Since I don't live in the UK, [an eSession] is the only way to attend a tutorial. So I guess I will make do
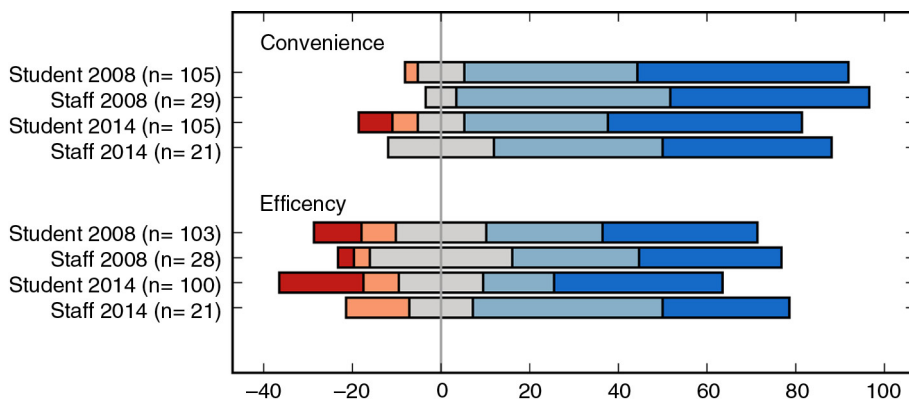
Figure 4.   Responses for convenience of eSessions for learning (students) and teaching (staff) and whether eSessions were an efficient use of time.

with the technical shortcomings and will of course attend all tutorials on offer'. and 'I just wouldn't be able to get to any in person'.

Convenience was also emphasised by tutors: 'The convenience of [eSessions] is a real bonus, particularly when the weather is bad and may impede travelling to the tutorial venue (for both students and tutors)' and one student reported: 'For the present course, the … eTutorial was far more convenient than having to travel a 70 mile return journey for a face-to-face tutorial', but, for one student, convenience was the only advantage: 'I don't have to leave the house. That's about it. Otherwise I much prefer physical face-to-face classes'.

However, it seems that convenience does not necessarily lead to big attendance. As one tutor remarked: 'In the early days of using [eSessions], I expected a larger number of students to attend eTutorials, due to the convenience, but over the years, whilst it may be the case that a small number of additional students attend, it generally tends to be the same students who would normally attend a face-to-face tutorial. The numbers of students attending [online] tutorials has not been significantly larger, in my experience'.

Accessibility

Respondents self-identifying as disabled were asked to comment on their experiences of eSessions and on any accessibility issues. In 2008, 9 of the 105 students (8.6%) responded, as did 2 of the 29 tutors (6.9%). In 2014 these figures were 6 out of 106 students (5.7%) and 2 out of 21 tutors (9.5%). In 2014, the two disabled tutors raised no disability issues. Although the small number of respondents demands caution and any conclusions must necessarily be tentative, it is interesting that the comments divide into two groups:

    A. visual/aural/cognitive disabilities (including dyslexia)
    B. physical/psychological disabilities.

Group A respondents experienced serious difficulties with aspects of the virtual classroom. A dyslexic student found the 'size of text on white[board] was sometimes too small' and 'struggled to cope with all the different areas of the screen that were

operating at the same time'. A partially sighted student likewise 'had difficulty following what was going on, mainly because there were so many different activities simultaneously, and [the] screen reader can only focus on one at a time'.

A second dyslexic student was not keen on eSessions, commenting: 'I get a lot more out of personal contact, and explaining things over the phone is just as bad'. Another commented: 'I have a hearing impairment and need to lipread – this was not possible with [eSessions] so I feel disadvantaged', a view not limited to those with auditory impairments: 'Being visually handicapped, I had difficulty keeping track of what was going on'. However, one student commented 'I am hearing impaired but it doesn't cause too many problems as I can control the audio on my computer. In addition if I miss something I can listen to the recording afterwards. The tutorials I have attended do not have too much audio interaction with students which does help me. I have also found that the tutors speak clearly which is a huge help'.

However, Group B respondents were much more positive on their experience. One student described eSessions as 'one the highlights of the course'. Several further quotations suffice to illustrate student viewpoints:

> I suffer from severe chronic clinical depression and have never attended a tutorial because of problems related to confidence, etc. The online tutorial was excellent for me, and I thoroughly recommend its use for those consistently unable to attend tutorials.
> Yes, I am disabled and without the [eSessions] I would not have had any tutorials.
> It saved my travelling and having to face people if I am too ill. I could 'leave the room' if I wanted and to [be] able to playback at my own time was brilliant.
> As a wheelchair user not having to get into a crappy inaccessible building was a bonus.

It is notable that for some disabled students the disadvantages are at least ameliorated by the possibility to playback a recording of an eSession.

Recordings and privacy

The virtual classroom has a recording facility, providing an almost complete record of the eSession for future playback. Many tutors take advantage of this facility to provide a resource for students, although this varies between tutors and module. The recording is generally made available to the tutor's own students, including those who had not attended the live eSession. If required, a recording can also be made available more widely.

In the 2008 trial, 24 out of 29 tutors (82.8%) recorded at least one eSession and 66 out of 105 students (62.9%) attended an eSession which was recorded. However, only 33 (31.4%) actually accessed a recording. In 2014, 78 out of 106 students (73.6%) had accessed a recording, including sessions they did not attend; a significant increase. Of the remainder 12 (11.3%) answered 'Not applicable', most likely because their tutors had not recorded sessions, with 16 (15.1%) not having accessed a recording. In addition, there were several students who were not captured in detail by the survey who indicated that they had accessed recordings without having ever attended a live eSession.

Students are typically warned in advance that the eSession might be recorded and the assent of all students attending is required for the session to be recorded. These precautions are necessary because the recordings are not easy to edit and the whole session 'warts and all' is available to students for replay, although not for permanent download without the use of screen capture software. Any mistakes or slips by tutor

or students are faithfully preserved, potentially causing embarrassment to those affected. Indeed, there is a concern that the act of recording itself might have a detrimental effect on the eSession, with students unwilling to participate and tutors sticking too carefully to prepared scripts.

Table 1 summarises the responses on whether recordings affected the model of participation. Three students reported that they would be inhibited from speaking or asking questions. However, one student said they were 'more relaxed' because they 'did not bother taking notes, but instead concentrated on what the tutor said'. A second reported: 'If you lose track of some complicated reasoning, but felt that all necessary explanation was covered by the tutor, you would not feel the need to ask to go over it again if it was recorded'. Some students noted that they were 'more self-conscious, less likely to answer if unsure of [the] answer' and 'holding back a little on writing comments/questions'. One student commented: 'The group and I appeared slower to offer opinions and answers, obviously conscious of the recording, but that said, I'd still vote for it due to the value of accessing the recordings of the sessions which I was unable to attend'. Another wrote: 'It can be quite difficult to get interaction going in [eSessions] and this may be more so if students feel that a wrong answer will be recorded for posterity!'

Tutor opinion was similar. Two noted that they had been affected initially but the effect had been transient, although one of them added: 'My concern is that if tutors are routinely recorded they will be less inclined to experiment and stick to things that will go smoothly'. A third commented: 'It made me watch what I said a lot more! And made me think about what I was saying so that those listening later would have a full understanding of what was happening. Recording certainly made me try to do a more professional job, and enhanced the actual live tutorial too, therefore'. Other tutors' comments included: 'It makes me less informal', 'it adds to the pressure of the session', 'I find recording inhibiting and so do the students I have asked' and 'students are affected by the fact that they are being recorded and are distracted from learning'.

Recordings have a potentially unlimited lifetime and it was useful to gauge student and tutor opinion on the appropriate length of time a recording should be kept. We also probed opinion on the types of use to which a recording might be put.

Figure 5 shows opinions on the retention period of a recorded eSession. Staff views on this issue were broadly the same in 2008 and 2014, with a small group that has no objection to recordings being kept indefinitely. The majority opted for a retention period of 2 years or less. Student opinion differed somewhat between 2008 and 2014: 81.9% of students opted for 2 years or less in 2008, while this was reduced to 64.2% in 2014, with a significant group (30.5%) favouring indefinite retention. This change most likely reflects greater student awareness in 2014 of the utility of recordings.

Table 1. The effect of recording on mode of participation.

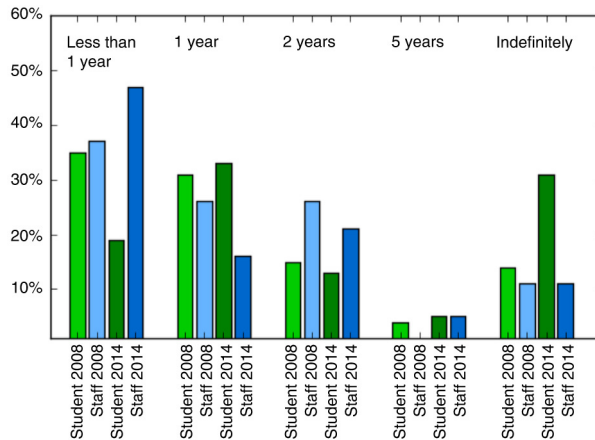| Did the fact that the session was recorded affect the way in which you participated in the [eSession]?	Yes	No	Total
Student 2008	6 (7%)	78 (93%)	84 (100%)
Staff 2008	3 (12%)	21 (88%)	24 (100%)
Student 2014	11 (20%)	43 (80%)	54 (100%)
Staff 2014	4 (22%)	14 (78%)	18 (100%)

Figure 5. Student and staff opinion on how long an eSession recording should be retained.

The quality of the recordings was a concern. One respondent commented: 'This is a live almost amateur presentation and would not compare well with broadcast quality media with professional recording editing and effects'.

There is considerable concern that increased use of technology (especially the Internet) has had a negative impact on the privacy of individuals, and, with this in mind, both staff and students were asked to comment on any issues that concerned them with regard to the recording of eSessions. In 2008, several students and tutors raised privacy and data protection as concerns, with one suggesting: 'Anonymity of students participating should be confirmed', and another suggesting that it would be difficult to 'manage issues where a participant makes a statement they later regret'. One student strongly disagreed with recording a session in which a webcam was used. A tutor suggested only first names should be displayed by the system; currently the full name of each participant is visible to all. In 2014, attitudes were somewhat more relaxed. One student commented: 'I don't know what the fuss is about recording' although another suggested 'names should be hidden to give privacy'.

It is hard to reconcile all of these concerns raised by respondents. Indeed, as one tutor commented: 'I like students to participate actively in sessions as far as possible. I want them to have a go at answering questions even if they get them wrong. I think that they are less likely to do this if the session is recorded, so it will become more of a lecture from me. I am also concerned that fewer students would attend the "live" sessions. On the other hand, I am aware that students cannot always attend tutorials at a particular time and would benefit from a recording. If I was given the choice, I might opt for a halfway house with some of the tutorial being recorded and some not, but this would involve more organisation'.

Discussion and conclusions

This study reports on student and staff perceptions of synchronous online learning eSessions, focussing on surveys conducted in 2008 and 2014. In this section, we return to the three research questions posed in the Introduction.

1) *Have tutor and student attitudes to the use of virtual classrooms changed over the 5 years since their introduction, and if so, how?*

In both surveys, students generally liked the convenience of online tutorials, and especially appreciated them when no alternatives were possible, although face-to-face was considered better if available. The ability to interact with other participants was praised, but many also felt the online sessions could be made more engaging and more interaction could be encouraged. This view was more marked in the 2014 survey. Student experience varied greatly with tutor and/or module. There was some feeling tutors might be better trained in the use of the medium.

Over the period of study, students perceptions of the usefulness of text-chat has decreased slightly, as has their view of application sharing, in contrast to the staff whose perception of application sharing has slightly improved over time. The perceptions of the effectiveness of breakout rooms and the use of webcams decreased in both the staff and student groups over the period of study. We note that students' ability to use virtual rooms and expectations of the software may have been influenced the increased use of systems such as Skype and Facetime in the general population.

2) *Has the use of virtual classrooms reduced or mitigated the transactional distance in distance education and helped build a community of enquiry, especially for disabled students?*

Transactional distance is a function of three aspects: dialogue, structure and learner autonomy (Moore 2013), while, according to Evans and Haughey (2014), the three elements needed to build a community of enquiry are: teaching, and social and cognitive presences.

In the studies presented here, the lack of interaction reported by students and tutors suggests a reduction in dialogue, with the result that eSession often becomes more of a one-way lecture, hence increasing the structure of the eSession. Both of these factors adversely affect the transactional distance. Whilst this overarching view appears to contradict the results of McBrien, Jones, and Cheng (2009), many of the individual student comments they report reflect those obtained in the current study. As reported above, students did appreciate the eSessions and transactional distance is certainly mitigated by virtual classrooms when there is no face-to-face alternative. These seemingly contradictory results may be a consequence of the domain of study. Here, the subject material (mathematics and computing) often requires the use of technical notation that is currently difficult to communicate within the virtual classroom, where as McBrien *et al.* considered students of the social sciences. Wang, Mattick, and Dunne (2010) also reported interaction difficulties with video-linked and streamed medical lectures.

For the community of enquiry model, the teaching element is certainly present within the scheduled eSessions although the limited social interaction (Figure 3) and the unidirectional nature of eSessions referred to above present problems for social and cognitive presence. It appears that virtual classrooms may help in building a community of enquiry, but are not sufficient by themselves.

For some disabled students, this difficulty of communication is considerably less than the difficulties encountered when attempting to attend a face-to-face session, and thus transactional distance is reduced for these students. For others, principally those

with auditory and visual disabilities, the difficulties presented by the synchronous online teaching software increases considerably the transactional distance and decreases significantly social and cognitive presence, at least over face-to-face events. Of course, without the option of a face-to-face alternative, the provision of online eSessions can be an asset for all students, provided no disabled student feels disadvantaged and/or marginalised by the difficulties associated with synchronous online teaching.

3) What are student/tutor attitudes to the recording of online sessions?

Students expressed strong support for the recording of eSessions, finding the ability to review an eSession at their convenience particularly valuable. In general, other issues associated with recordings provoked mixed views. Students and staff alike did express privacy concerns, although this was not a major worry. There were requests that recordings be well catalogued and that the interface for viewing them should be sufficiently sophisticated for the purpose. There was some concern that the nature of an eSession was changed by the act of recording, but others thought the additional care taken by both the tutor and students in a recorded session improved the standard.

We conclude by reporting on 2014 staff and students' reported intentions regarding future use of eSessions. Of 21 staff, 17 would be highly likely to give an eSession in future and 80 of 100 students would similarly be highly likely to attend an eSession if offered in the future. Perhaps more surprisingly, the availability of eSessions in addition to other tutorial provision may incentivise students to register for study. These facts in themselves suggest that online tutorials will continue to be a component part of distance learning in the future. As one enthusiastic 2014 student put it: 'I will definitely be requesting [eSessions] for my next module and really hope that I get them!'

Recommendations

A number of recommendations regarding virtual rooms and their use for distance learning are apparent from this study.

(1) Distance-learning courses should include the use of eSessions to support students; however, they should be used as a supplement to, not as a replacement for, face-to-face sessions.
(2) Developers of virtual classrooms should include better support for the communication of mathematics and other symbolically-rich disciplines.
(3) Developers of virtual classrooms should better consider the needs of disabled users in future designs of their software.
(4) Future studies of this nature should consider the demographics and the backgrounds of students surveyed, including prior experiences of synchronous Internet communication tools.
(5) Where appropriate to the content, eSessions should be recorded, subject to obtaining the permission of all participants. In general such recordings should be kept for a maximum of 2 years. Participants should be given advanced notice of the possible uses to which the recordings might be put.

(6) For large student groups, it may be more effective to record shorter eSessions without students present rather than to record a live tutorial.

(7) Tutors leading eSessions should share best practice in the use of virtual classrooms.

Acknowledgements

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