Web conferencing for synchronous online tutorials: Perspectives of tutors using a new medium

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ABSTRACT

This paper reports on a pilot investigation into web conferencing in a distance learning module. It focuses on the perceptions and experiences of the tutors, all of whom were new to the web conferencing environment, but were experienced in online teaching. A number of web conferencing tutorials were studied through the collection of various datasets, mostly qualitative. The data were analysed by a team of researchers, informed by key literature in this area.

The main findings from the pilot indicated that tutors experienced challenges in creating social presence and in managing cognitive load when dealing with multiple tasks online. There were also technical obstacles to improvisation in response to students' emerging needs. The findings of the pilot informed the training and support provided when web tutorials were subsequently rolled out to all tutorial groups (approximately 140) in the module. Overall, experiences from the web tutorials indicate that tutors and students reacted positively to the opportunities web conferencing provides for interactive learning and teaching.

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1. Introduction

In recent years internet-based technologies have spread rapidly into all aspects of everyday life. The advent of web-based social software has further increased the embedding of online communication into work and leisure activities (Donelan, Kear, & Ramage, 2010; Joinson, McKenna, Postmes, & Reips, 2007). In many respects, the field of education has been at the forefront of advances in online communication. The question of how communications media can be used to reduce the "psychological and communications space" (Moore, 1993, p. 22) between teacher and learner in distance education has been the subject of research for many years. Now, universities and colleges are experimenting with a range of social software tools in order to support learners and build communities (Kear, 2011; Mason & Rennie, 2008).

To date, the use of online communication for learning has focused primarily on asynchronous technologies such as discussion forums (Kear, 2004; McConnell, 2006). Asynchronous communication provides many benefits for learners, for example convenience and flexibility, but it also has disadvantages. Learners can feel that it is impersonal, and that they are not interacting fully with their teachers or with other learners (Vonderwell, 2003). The lack of scheduled interactions can mean that learners fall behind because they do not allocate time for the necessary learning activities (de Freitas & Neumann, 2009). These problems, and others, can lead to low levels of participation in asynchronous online learning (Skinner, 2009).

One possibility for addressing these issues is to use synchronous (real-time) online communication. Synchronous technologies range from chat rooms, through instant messaging tools to desktop video-conferencing systems (Finkelstein, 2006). Synchronous communication can enhance participants' sense of social presence (Short, Williams, & Christie, 1976), so that the communication feels real, even though it is mediated by technology (McInnerney & Roberts, 2004). Real-time communication can also help students to feel a sense of belonging (Haythornthwaite, Kazmer, Robins, & Shoemaker, 2000). The 'richer' synchronous technologies, such as audio- or video-conferencing, can add significantly to the social presence of participants, providing a more human feel to the communication (Loch & Reushle, 2008). These

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synchronous conferencing technologies are now available on desktop or laptop computers, with communication taking place via web-based interfaces. This opens up many possibilities for real-time online learning and teaching.

Web-based audio- and video-conferencing systems are described using a number of different terms, for example: synchronous online environments (Hampel, 2006); web conferencing (Loch & Reushle, 2008). In this paper we will use the term 'web conferencing'. The boundaries between web conferencing systems, instant messaging tools such as Windows Live Messenger (explore.live.com/windows-live-messenger) and Voice over IP tools such as Skype (www.skype.com) are rapidly blurring, as the latter tools gain video facilities and offer multi-user communication. Web conferencing tools can provide a close alternative to face-to-face learning (Barron et al., 2005), without the need to travel. These technologies therefore offer significant advantages in terms of convenience, cost-saving and 'eco-friendliness', and there is increasing interest in their educational use.

Web conferencing can support a range of communication modes (Ciekanski & Chanier, 2008) such as audio, shared whiteboards and text chat, and students value these features (Rowe, Ellis, & Bao, 2006; Saw et al., 2008; Wang & Chen, 2009). There are many different systems available that offer similar main features. Some of these systems also include video communication, although there has been some debate as to the value of video in real-time conferencing (Maturazzo & Sellen, 2000; Rosell-Aguilar, 2005). These various modes provide opportunities for many kinds of learning and teaching activities, such as group discussion, role-play and brainstorming (Hampel, 2006).

However, the combination of different media, used in real time, can place a high cognitive load (Chandler & Sweller, 1991) on learners and teachers, particularly when they are new to web conferencing. The need to split attention among auditory, textual and visual material makes high demands on limited working memory and can result in cognitive overload (Kirschner, Ayres, & Chandler, 2011; Mayer & Moreno, 2003). Care is therefore needed to ensure that parallel use of the different tools does not confuse learners or overload teachers (Hampel, 2003; Wang & Hsu, 2008). The multimodality (Kress & Van Leeuwen, 2001) of these environments can then be a benefit rather than becoming a problem.

Careful planning and design are needed for successful synchronous e-learning events, but the real-time aspect means that learning and teaching in these environments is never predictable. Teachers need to adapt their approaches to learners' responses and needs. Effective teaching in web conferencing environments therefore requires a skilled balance of planning and moment-by-moment adaptation. In relation to face-to-face teaching this has been described as 'disciplined improvisation' (Sawyer, 2004). Sawyer (p. 16) suggests that the disciplined improvisation metaphor leads to the following questions:

"(a) What sorts of guiding structures are appropriate in what kinds of settings and subjects? (b) How can teachers learn to improvise effectively within structures? (c) When should teachers stick with the script and when should they improvise creatively?"

One aim of this study is to explore how the construct of disciplined improvisation, and Sawyer's questions above, apply in a web conferencing environment, and how this might differ from a face-to-face setting. Sawyer (p. 15) mentions aspects, such as managing turn-taking and the degree of simultaneity, which seem very relevant to web conferencing, as well as to face-to-face settings. One difference between the two settings is the degree to which teachers can judge the reactions of students. In a face-to-face context, the teacher would notice learners' facial expressions (e.g. a puzzled look) or body language. However in a web conferencing environment, these aspects are more difficult to discern (Wang & Hsu, 2008).

The current challenge is to identify how web conferencing tools can best be used for learning and teaching. As de Freitas and Neumann (2009) have pointed out, much of the literature available is in the form of practical guides (see, for example, Anderson et al., 2006), rather than documented research findings. Valuable research has been carried out in relation to language learning (Lamy & Hampel, 2007), and the investigation of web conferencing in other subject areas has started to emerge. For example, Loch, Reushle, Jayne, and Rowe (2010) conducted a large-scale study into the use of web conferencing in subject areas including computing and business. McBrien, Jones, and Cheng (2009) explored students' experiences of web conferencing in courses in education.

The present paper contributes to the work in this area by focussing on the tutors' perspective, in particular tutors experienced in providing face-to-face and asynchronous online support but new to web conferencing. The paper reports on an investigation into the use of web conferencing in a distance learning module on information and communication technologies, presented by the UK Open University (UK OU). The investigation addressed the following research questions:

1. What are the benefits and issues of using web conferencing to support learning?
2. How does teaching via web conferencing compare with face-to-face teaching?
3. What strategies are effective for teaching via a web conferencing environment?
4. What is required to support teachers, both pedagogically and practically, who are new to web conferencing?

2. Context of the research study

2.1. The educational setting

The UK OU is the largest provider of distance education in the UK, with over 250 000 undergraduates. On the majority of modules a group of between 15 and 25 students is allocated to a tutor, usually geographically local to the student. The tutor is responsible for providing support for students through a mix of:

- face-to-face tutorials at a local centre
- online tuition
- individual help by email or phone
- written feedback on students' assignments.

Students submit their assessment answers electronically to their tutors, who return them with detailed written feedback. A module's teaching and assessment materials, in the form of printed and online resources, are created by central staff working in module teams.

The module which is the focus of the research presented in this paper is *Networked Living: Exploring Information and Communication Technologies*. This is a first year undergraduate module worth 30 points in the UK's Credit Accumulation and Transfer Scheme (CATS), and roughly equivalent to 15 points in the European Credit Transfer System (ECTS). The module runs over 9 months and requires around 8 h of study per week. The research project investigated use of the web conferencing tool *Elluminate Live!* (now encompassed in Blackboard *Collaborate*, but subsequently referred to in this paper as 'Elluminate'), which is provided as part of the UK OU's virtual learning environment. In the 2009 presentation of the module, six of the tutors of *Networked Living* volunteered to provide an additional tutorial for their tutor groups (around 15 students per group) via Elluminate.

Experience has shown that some of the students on *Networked Living* struggle with the numerical parts of the module, and therefore ways to provide additional support for numeracy are of value. Synchronous communication using voice and whiteboard can provide considerable interactivity between students and tutor, and among students (Mason & Rennie, 2008), so this technology has potential for students' learning of numerical concepts and procedures (Loch & Reushle, 2008). The real-time communication can also help students to feel a sense of belonging within their student cohort (Haythornthwaite et al., 2000). It was therefore felt that a trial of Elluminate web conferencing for numeracy support would be of value. If the technology proved successful, it would then be used across all tutor groups in subsequent presentations of the module.

The six tutors invited their students to take part in a supplementary tutorial, via Elluminate, in the later stages of the module. The tutorial, of about an hour's duration, focused on numeracy, in particular the use of a 'formula triangle' to manipulate simple three-term algebraic equations in order to carry out calculations. The tutors were asked to record the tutorials for future analysis (provided their students were happy for them to do so), using the recording facility that is available within Elluminate.

When the research was carried out, Elluminate was new to the UK OU, although the *Lyceum* in-house audio-conferencing facility (which offers audio but not video communication) had been used previously on some other modules (Hampel, 2006). None of the six volunteer tutors had used Elluminate before for teaching. Initial training was therefore provided in order to introduce tutors to the numerous features of the Elluminate interface and to identify aspects where additional scaffolding was required.

The tutors each offered their students a familiarisation session in Elluminate a few days before the actual tutorial. This was to help students get used to the software and equipment (microphone and headphones) that they would be using for the tutorial. The familiarisation session also gave the tutors an opportunity to try Elluminate with students before the tutorial itself.

Sample tutorial resources were created by members of the module team for tutors to use as the basis for their tutorial. These were slides which could be uploaded to the Elluminate whiteboard. The slides contained worked activities for tutors to use with their students, followed by activities for students to carry out. Tutors were free to use the slides unchanged, to modify them, or to design their own tutorial resources from scratch.

2.2. The web conferencing environment

Fig. 1 shows the students' view of the Elluminate environment. A shared, interactive whiteboard occupies the right two-thirds of the screen, providing an area for displaying pre-loaded content or for adding in-session content, such as text (typed or hand-written) and pictures. Presentations can be prepared using other applications and pre-loaded, or prepared within Elluminate and saved to a file. Presentations prepared by the former method cannot be changed during the session (though objects can be placed on them using the whiteboard tools), but those prepared with the latter method can. Elluminate provides a selection of tools for adding or changing whiteboard content, together with tools for pointing to items on the whiteboard, and moving them.

The *Participants* window in the top left of the screen lists the names of the participants (in Fig. 1 the students' and tutor's second names have been removed to preserve confidentiality). It also shows icons to indicate each participant's current activity status – for example whether they are using their microphone, or using the whiteboard pen. The *Chat* facility is in the middle left area of the screen. This allows participants to type in comments or questions without interrupting the person who is speaking.

At the bottom left of the screen is an area where participants can access a microphone icon in order to make spoken contributions. Elluminate has different modes of operation for spoken interaction. It is possible to use an open microphone mode where several participants can speak at any time, but this can cause problems with audio feedback (echo). An alternative mode of use is to have the microphone open to just one or two participants at a time. In this mode a more structured 'handing over' of the microphone is required – by clicking on the microphone icon in the bottom left hand corner of the Elluminate window.

The Elluminate environment provides many additional facilities that are not shown in Fig. 1. Participants with video cameras can opt to have a live image of themselves shown in a pop-up window on screen. 'Breakout rooms' allow subgroups of participants to work together privately. Tick and cross icons enable participants to indicate simple yes/no answers and emoticons provide a means for participants to indicate laughter, applause and so on. Participants can also use a 'hands up' icon to indicate that they have something to say.

3. Methodology

A mixed methods approach was taken in order to address the research questions. This involved a number of different data collection methods (see Table 1), resulting in both qualitative and quantitative data, although the majority of the data were qualitative. Creswell (2003) describes a number of mixed methods approaches; the general strategy adopted here is closest to that described by Creswell as 'concurrent' (p. 16), where qualitative and quantitative data are collected in parallel and then converged, in order to provide answers to the research questions being posed.

The research was approved by the Open University's Student Research Project Panel prior to the work commencing. The Panel reviews the research methodology and any survey or interview questions being used, and ensures ethical guidelines are followed. The tutors who took part in the study volunteered, in response to an open invitation to all the module tutors. Students in these tutors' groups were approached via email and invited to take part in a tutorial via Elluminate and to respond to an online survey.

The methods used to collect different forms of qualitative data are described below in 'Method I', 'Method II' and 'Method III'. Some of these methods were employed earlier than others and therefore were instrumental in eliciting the initial themes to be explored. The data
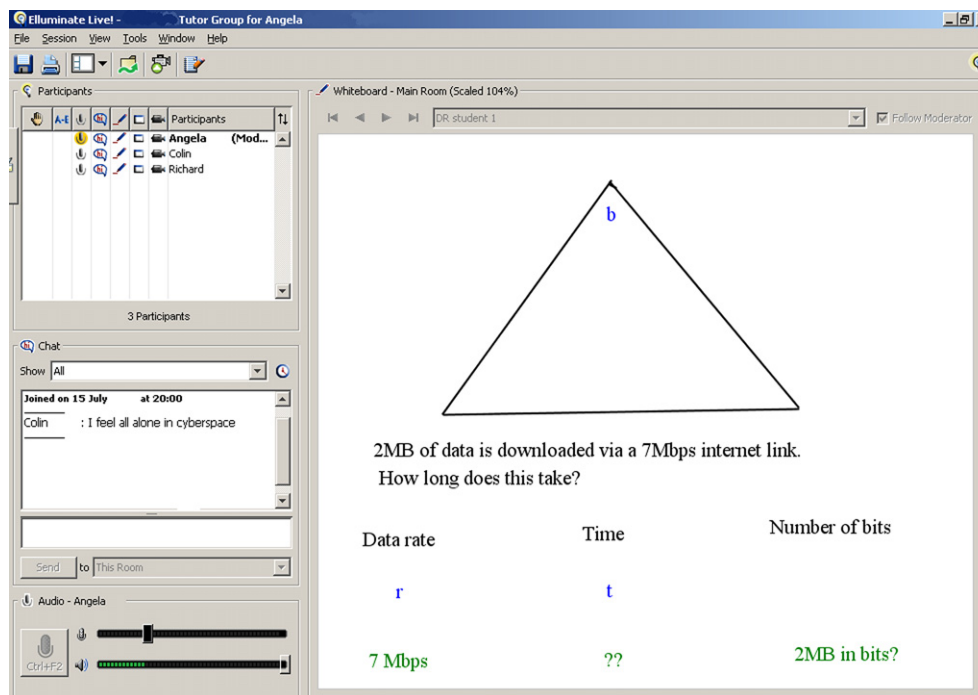
Fig. 1. A student's view of the Elluminate environment.

gathered later were used to verify and investigate these themes in more detail. The collection of quantitative data was via a student survey, as described below in 'Method IV'.

This approach suited the current study well as there were various perspectives on the research questions being explored: namely the tutor perspective, the student perspective and the perspective of an observer (the research team). The mixed-method, concurrent approach was used as a framework for the research, and served to triangulate the findings. However, it is the tutor perspective that is the main focus of this paper.

3.1. Method I: eliciting tutors' views via an online forum

The first method for data gathering focused on the collection of initial tutor feedback. An asynchronous discussion forum was used to collect tutors' thoughts and opinions when they had completed their familiarisation sessions with students, and subsequently their actual tutorial sessions. This approach ensured that tutors' immediate impressions were captured, and it allowed the tutors to share and comment on each other's experiences. These data were collected early in the research project, and helped to identify themes and topics that could be then be explored in more detail.

3.2. Method II: eliciting tutors' views via online focus groups

Two online focus groups in Elluminate were held for tutors. Focus groups are of value for investigating questions that are not yet well-defined, and for collecting data about perceptions and opinions (Anderson & Kanuka, 2003, p. 102). Holding the focus groups in Elluminate

Table 1
Summary of research methods.

Method	Purpose	Data gathered	Analysis
Method I: Online forum postings from tutors after their Elluminate sessions.	To gather tutors' initial thoughts.	3 postings about the familiarisation sessions. 6 postings about the tutorials.	Forum postings were analysed by 4 researchers.
Method II: Tutor focus groups held in Elluminate and recorded.	To gather tutors' reflections.	1st focus group: 4 tutors participated. 2nd focus group: the remaining 2 tutors participated.	4 researchers each analysed the focus group notes.
Method III: Elluminate tutorials recorded.	Observation of tutors and students by the research team.	4 recordings (technical difficulties meant that the other 2 failed to record).	One set of notes made of each recording, and then each set of notes analysed by 2 researchers.
Method IV: Online survey of all students in the participating tutor groups.	To gather students' perspectives including reasons for non-attendance.	77 students invited to complete survey, of whom 23 responded. 5 of these were among the 13 students who attended an Elluminate tutorial.	23 responses analysed by 4 researchers.

had the added benefit that the participants were in the environment where they had held their tutorials. This could help bring to mind their experiences, and those of their students, during the actual Elluminate tutorials.

The focus groups were led by a research team member who was an experienced Elluminate user. Each group also included one or two other members of the research team as listeners who could contribute if needed. Open-ended questions were asked about tutors' and students' use of Elluminate, aspects of the tutorial sessions and comparisons with face-to-face tutorials. The questions were used to encourage discussion and to gain insight into the tutors' opinions on their tutorials. The focus group questions included:

- How much interaction was there from students?
- Which tools did you (and students) use most?
- Did [students] seem to learn from [the tutorial]?
- How did the Elluminate tutorial compare with a face-to-face one?

A further benefit of holding the focus groups in Elluminate was that they could easily be recorded, using the facility provided within Elluminate. The recordings captured the spoken interactions, any text chat contributions, and a final 'brainstorm' whiteboard screen where each participant added their view of the main benefits and issues. Once each focus group was completed, the recording was viewed by a member of the research team, and notes were made for reference purposes. The recordings and notes were instrumental in further developing and verifying the research themes and topics.

3.3. Method III: observation of recorded Elluminate tutorials

Recordings of the Elluminate tutorials themselves provided a rich source of data for the research. The six tutorials took place over a period of ten days, either at the weekend or in the evening. They were optional, so participation was not expected to be high. In practice, between one and three students attended each (see Table 2). The students were asked prior to the start of each tutorial if they were happy for the tutorial to be recorded, and all the students gave their permission. Students were also asked to complete consent forms giving permission for their contributions to be used for research. Four of the six tutorials were recorded; unfortunately technical problems prevented the recording of the other two tutorials.

The recordings enabled the researchers (who did not attend the tutorials) to study the interactions and activities taking place, the approaches adopted by the tutors, and any problems experienced by tutors or students. At the end of some of the tutorial sessions, the tutor discussed with students the value of Elluminate as a teaching and learning environment. These discussions provided valuable insights into the student perspective.

The four recorded tutorial sessions were analysed by the research team. Members of the team listened to and watched the recordings, and made detailed notes of each session. This allowed each member of the team to form their own insights, based on observation of the tutorials. Later, discussions of these notes were held at face-to-face meetings of the research team. This facilitated a clearer definition of the themes and topics that had begun to emerge from the focus group data. It also allowed examples to be identified that reinforced or contradicted these themes.

3.4. Method IV: eliciting students' views via on online survey

A mixture of qualitative and quantitative data relating to the students' perspective was collected via an anonymous online survey. Bearing in mind the potential numbers of students involved (six groups of approximately 15 students), a survey seemed the most practical method for data gathering. Because the students were distance learners, and were used to engaging with materials online, it was felt that an online survey would maximise the response rate.

The survey used mostly multiple choice questions concerning students' experiences of using Elluminate. Open-ended text boxes were also provided to enable students to add comments. Students who had attended an Elluminate tutorial were asked about the value of the tutorial. Those who had not attended were asked why, as this information was considered valuable for informing the decision about whether to rollout the use of Elluminate on a larger scale.

The Student Research Project Panel review resulted in some students being excluded from the survey, for example because they were under 18, had already been surveyed during that academic year, or had previously indicated that they did not wish to be contacted for research purposes. The final sample of students was 77 after these exclusions were taken into account. Of these 77 students, 23 responded (30%). However, although a total of 13 students attended an Elluminate tutorial, only 5 of these (38%) responded to the survey. Therefore the data describing the student experience are much less rich than that describing the tutor experience. This paper primarily presents the tutor perspective, with students' views added where relevant.

Table 2
Attendance and recording of the Elluminate tutorials.

Tutorial	Number of students attending	Tutorial recorded successfully?
1	3	Yes
2	1	Yes
3	2	No
4	3	Yes
5	2	No
6	2	Yes

3.5. Data analysis

The data collected via the methods described above were analysed by a team of four researchers (the authors of this paper). This analysis was carried out at a series of face-to-face workshops, with online discussion and information-sharing taking place between the workshops. The data analysis was primarily qualitative in nature, and aimed to elicit themes and key issues. The analysis was informed by the research literature presented earlier in this paper. However, the general approach was to allow the data to 'speak for themselves', rather than to investigate specific hypotheses. The data analysis activities are summarised in the fourth column of Table 1 (referred to earlier).

At the first data analysis workshop, the researchers noted key points and themes from the various datasets described above. Initially these points were grouped into five topics:

1. Preparation and improvisation
2. Multimodality
3. Social presence
4. Pedagogical strategy
5. Usability and practical issues.

The datasets were then reviewed in detail, and coded according to these topics. This process revealed that the issues being coded under 'Social presence' covered a broader range of issues surrounding interaction and participation, rather than just concepts associated with social presence. This category was therefore renamed as 'Interaction and participation' to be more encompassing. Additionally, 'Pedagogical strategy' was often coded together with either 'Usability and practical issues' or 'Social presence'. There were only a few points coded under 'Multimodality', and these were also covered under other topics. Therefore, in a further phase of analysis, the points under 'Pedagogical issues' and 'Multimodality' were re-assigned, in order to draw out just three overarching themes:

- *Preparation and improvisation*: the need for preparation of tutorials beforehand, together with improvisation (Sawyer, 2004) while presenting them;
- *Interaction and participation*: issues related to running the tutorials as interactive and social events;
- *Usability and practical issues*: the practical, technical and usability aspects of running the web conferencing sessions, and dealing with the multiple communication tools.

4. Findings

This section presents a summary of the findings from the data gathering and analysis. It is divided into three subsections corresponding to the three overarching themes, identified above, which emerged from the data analysis. Although there was some overlap between these three themes, they serve below as one way of presenting the research findings.

4.1. Preparation and improvisation

In the feedback from tutors, there was discussion of the extent to which the tutorials were planned beforehand, and the extent to which tutors needed to adjust and improvise their teaching at points during the session itself. Tutors commented that preparation for Elluminate tutorials took longer than they expected and they found it useful to practise beforehand with friends or family in order to develop confidence. Running familiarisation activities for students before the main tutorial was considered useful for developing tutors' confidence, as well as that of the students.

Tutors were questioned about the value of having tutorial resources prepared for them by the module team. There was general agreement that this was useful, particularly at this early stage when the tutors were still new to the technology. The tutors commented that the resources gave a good starting point, saved time and provided ideas for how they might generate their own resources in the future. None of the tutors indicated a preference for creating their own resources from scratch at this stage, but most tutors modified the resources before using them. Several of the tutors said that they changed the resources considerably, and that this process made them feel more comfortable using them.

Tutors commented that they already had a range of materials prepared for use in face-to-face tutorials, but they were starting almost afresh with Elluminate. They would need to spend some time preparing further resources: either modifying existing materials or creating new versions suitable for use with Elluminate. A further comment was that it would be useful to share resources among the tutor community. This was already established practice for tutorial materials used face-to-face or via discussion forums.

Moving on to consider the experience of presenting the tutorials, tutors made the point that they needed to adjust in real time to students' needs. One of the main challenges tutors faced was coping with groups of students with mixed mathematical abilities. Firstly, they felt that identifying students who were ahead of the concepts being taught, or students who were struggling, was more difficult when using web conferencing than when tutoring face-to-face. This was mainly due to the lack of facial expressions and body language. In addition, some tutors struggled to adapt pre-prepared material or create new material in the web conferencing environment (without having specialised technology such as a graphics pen). For example, in one of the Elluminate tutorials only one student, who was already very competent with numeracy, attended. This made the tutorial difficult for the tutor to handle because she could not easily adjust the material to suit the student. As a result she simply "stuck to the script", and felt that the session was not very satisfactory.

Several further points arose from observation of the four recorded Elluminate sessions, which highlighted differences in tutors' approaches. For example, only one tutor included an 'ice breaker' activity at the start of the tutorial session. There were also noticeable differences in the tutors' use of the prepared slides, their use of the Elluminate facilities, and their degree of improvisation.

4.2. Interaction and participation

Motivating students to attend the tutorial was reported as being difficult. This matches the experience of UK OU tutors when face-to-face tutorials are offered. In the student survey, 36% of respondents said that they rarely attended a face-to-face tutorial. Common reasons for not attending face-to-face tutorials were travel difficulties and time constraints. Common reasons for lack of attendance at the Elluminate tutorial were: the chosen time being unsuitable; technical difficulties; lack of the required hardware. The low numbers of students participating in sessions made it difficult to ascertain whether the levels of interaction were any different to those that would have been observed in a face-to-face environment. The tutor's perceptions and the observations of the research team are summarised here, but these are tentative findings that may have differed for larger groups.

Tutors' perceptions of the levels of interaction in their tutorial sessions varied, and did not seem to relate to the number of students attending. For example, the tutor who had only one student at her tutorial still felt it was quite a social and interactive session. For other sessions, where there were two or three students, some tutors reported little interaction from students, while other tutors felt that their tutorial sessions had a good level of interaction. From observation of the recordings, it appeared that tutors contributed significantly more than students. This was particularly the case at the beginning of a session, when students were slow to speak. In the sessions where tutors reported a good level of interaction, there were regular instances of students responding verbally to the tutor's questions. Although students' contributions were relatively minor, they had an effect on the tutors' perceptions of the social feel of the session. However, there was limited interaction between students themselves. One of the few examples of students talking to each other was when the tutor was absent for a few minutes, fixing a technical problem.

In terms of the facilities that were used in the tutorial sessions, the tutors agreed that audio was vital for creating a social atmosphere. Text chat was used very little and it did not seem to have contributed significantly to these particular sessions. Tutors commented that text chat was useful when there were audio problems, and for welcoming students as they arrived. Students showed a slight preference for using text chat compared with making verbal contributions.

For drawing their students' attention to items on the whiteboard, tutors used Elluminate's pointing tools, and one tutor used a black square to cover and reveal sections of the screen. To elicit feedback from students, several tutors used the tick/cross (or yes/no) facility. In one particular session, where one of the three students did not have a microphone, and another had a problem with 'echo', the tutor encouraged the use of the tick/cross and text chat facilities. The result was some interaction but very little verbal contribution from any of the students.

One example of student interaction was in response to an exercise on the formula triangle led by one of the tutors. Having explained how the triangle could be used to rearrange simple three-symbol equations, the tutor put up a whiteboard slide showing several triangles and sets of symbols, with each set in a different colour. He asked the three students to each choose a different coloured triangle and drag the symbols into position to represent the equation. The students did this, with two producing the correct positioning and one placing the symbols incorrectly. The tutor gave some verbal feedback, then returned to the slide where he had explained how the formula triangle worked, in order to explain further. He then asked if the students were now all happy with this. The student who had made a mistake typed 'OK' in the chat area and the other two clicked the 'tick' icon.

When questioned on the success of web conferencing for learning, and particularly for numeracy work, tutors commented positively on the visual and interactive aspects. They highlighted the benefits of being able to manipulate and change numbers on the whiteboard (not on pre-loaded content), though one tutor mentioned difficulties with keyboard input of mathematical notation.

Tutors acknowledged the social benefits that the sessions brought, but also commented on the lack of various types of communication cues (such as facial expression). One tutor tried to use Elluminate's video facility in order to provide some visual cues, but because he was using a slow dialup connection the video was effectively reduced to a sequence of still images. Another tutor said he had used video in training but felt it was "another thing to cope with" and that "you need to use it for a real purpose". No other tutors tried using video for their tutorials.

The inability to read students' facial expressions made it difficult for tutors to know whether students were keeping up with the tutorial content. One tutor commented that it is a problem "not seeing students' expressions, and what else is going on". Another tutor said "you can't see people and get them to join in as well as you can face-to-face […]. You can't see them and tell when they're bored or lost. I was just 'keeping going'. At particular points, tutors needed to ask students explicitly for confirmation that they were following - for example via the tick/cross icons. This made the tutorial slower than a face-to-face session, where this could be achieved quickly by glancing around the room. Tutors commented on how the lack of communication cues affected their own experience of the session. One tutor said he received very little verbal contribution or interaction from students. He felt this aspect was "very strange" and that it had turned the tutorial into more of a "monologue" to make up for the silence from students.

Tutors were asked if they felt that the Elluminate tutorials had helped them to get to know the students. Although five of the six tutors felt that there was a reasonable level of social interaction in their sessions, only one tutor specifically said that the tutorial had been good for getting to know students. When students were asked how easy it was to get to know other students in an Elluminate tutorial compared to a face-to-face tutorial, two of the four who responded said that the two contexts were equally effective.

At the end of some tutorials, the tutor asked the students how they felt the session had gone. The majority of students said that they enjoyed the interactivity and the multiple ways of communicating. They felt that Elluminate was more convenient than face-to-face tutorials, almost as good, and would be a good supplement to face-to-face events.

4.3. Usability and practical issues

Tutors valued the training they had received before their first session and, indeed, viewed it as essential. It had helped to build their confidence with the technology and with teaching techniques in the new environment. Some tutors felt that two training sessions were enough to get started, but others felt they needed more practice.

Problems in accessing an Elluminate session were experienced by some students and tutors. One tutor's router disconnected twice during her tutorial, causing an interruption while she reset it – though the students remained in session throughout. On two occasions,

institutional logon procedures to the Elluminate environment resulted in students and tutors finding themselves in different Elluminate sessions. One student, based overseas, arrived at a session an hour early owing to international time differences.

Some specific problems were reported in relation to audio interaction. Some students did not have microphones, while others could not make their microphones work. One student lost audio part way through, and audio from other participants sometimes seemed muffled or too quiet. On occasions audio 'broke up' and students' verbal contributions were 'clipped' at the end. Another problem was background noise from participants' home environments – for example, in one tutorial the sound of someone practising musical scales could be clearly heard.

Participants using a stand-alone microphone and speakers, rather than a headset, tended to introduce some distracting acoustic feedback (echo). This could be avoided by changing the Elluminate settings to limit the number of participants with an open microphone at any given time, so that students needed to take turns with the microphone. However, the practice of switching microphones on and off via the Elluminate interface sometimes resulted in a participant forgetting to activate their microphone, and not realising that others were unable to hear them. When commenting on the access and audio problems, one tutor said "[I] felt some of the same frustration that I've experienced in the past when turning up at a tutorial venue and finding that there was no data projector".

Tutors reported issues associated with the complexity of the Elluminate interface: "There's a lot to take in e.g. tiny little things to know and remember"; "There's a steep learning curve". One tutor made the comment to students, during her session, that it was hard to concentrate with so much going on. In contrast, students did not experience these difficulties, and said that they liked the multiple tools for interacting.

Tutors did not report any major problems with the software. However, a variety of minor technical issues were identified. Tutors commented on problems with alignment of items on the whiteboard, and there were also some comments about items not being visible for all participants (for example, a tutor's pointer not being visible to students.) Problems with synchronisation between participants' screens were also mentioned. The tutors felt it would be useful to experience the system as a student rather than a moderator. One tutor commented that it was "difficult to get to grips with the view the student has compared with my view as a moderator".

5. Discussion

In this section we return to the four research questions:

1. What are the benefits and issues of using web conferencing to support learning?
2. How does teaching via web conferencing compare with face-to-face teaching?
3. What strategies are effective for teaching via a web conferencing environment?
4. What is required to support teachers, both pedagogically and practically, who are new to web conferencing?

In the subsections which follow, each question is addressed separately on the basis of the research findings and analysis from the study. Table 3 provides a summary of how the findings, as categorised under the three themes, relate to the research questions. It should be noted that the first and second research questions share common findings because many of the benefits and issues of web conferencing were presented by tutors in comparison with face-to-face teaching.

5.1. What are the benefits and issues of using web conferencing to support learning?

The student survey (Method IV) identified that difficulties with travel and time constraints are common reasons for students not attending face-to-face tutorials. Web conferencing offers an attractive alternative and has the potential to engage and support these students. Data from the recorded sessions (Method III) highlighted the potential to produce a richer learning environment. However, the multimodality imposes a high cognitive load and requires tutors and students to develop competencies and confidence in this new medium.

Some tutors reported difficulties with concentration during their sessions due to the complexity of the interface, and some made comments about fatigue: "Yes, tiring, having to have one eye on the whiteboard and one on the chat window and one on the voting/

Table 3
Categorisation of findings under the three emergent themes.

	Preparation and improvisation	Interaction and participation	Usability and practical issues
What are the benefits and issues of using web conferencing to support learning?		Additional modalities – enjoyed by students.	Reduces travel and institutional costs. High cognitive load on tutors due to multimodality and technical problems.
How does teaching via web conferencing compare with face-to-face teaching?	More difficult to improvise. Face-to-face tutorial resources may not migrate well to web conferencing – new resources needed.	Lack of visual cues. Possibly less interaction between student–tutor and student–student.	
What strategies are effective for teaching via a web conferencing environment?	Familiarisation sessions valuable.	Strategies needed to increase student participation – breakout rooms might help.	Beneficial for tutor to manage access to microphone. If technical problems reduce students' use of audio, use text chat and polling.
What is required to support teachers, both pedagogically and practically, who are new to web conferencing?	Provide tutorial resources for tutors to modify and use. Value in sharing resources amongst tutors.		Experience/practice both as moderator (tutor) and as a student (participant). Formal training sessions.

emoticon space". One tutor talked of being more "wiped out" after an Elluminate tutorial than after a face-to-face tutorial because of the need to keep an eye on everything. However, he also commented that not needing to travel to the tutorial countered this.

In contrast, students seemed to enjoy the multimodality of the environment and found it "almost as good as face-to-face". However, it is worth pointing out that the trial for this study took place with ICT students who were probably relatively confident and competent computer users, familiar with working in online environments. Students in less computer-focused disciplines may need a gentler learning slope before they can confidently engage in web conferencing.

5.2. How does teaching via web conferencing compare with face-to-face teaching?

Many of the comments made by tutors in this study relate to differences in social presence between web conferencing and face-to-face environments. Tutors commented particularly on the lack of visual clues, which made it difficult to adjust their teaching approaches, for example being unable to see whether students looked confused or bored.

When using web conferencing, tutors found that students often did not respond verbally when invited to contribute. This could be due to the lack of eye contact, so that questions did not seem to be directed at anyone (the problem did not arise in the tutorial where there was just one student). It may also be due to the use of polling functions (ticks and crosses) as an alternative to spoken interaction. Tutors felt that both student-to-tutor and student-to-student interaction was lower than in a face-to-face environment. However, students can also be unwilling to contribute in face-to-face tutorials. The low student numbers in the Elluminate sessions make it difficult to draw any further conclusions on the levels of interaction.

Problems with improvisation were experienced by tutors when using web conferencing. In a face-to-face session, experienced tutors are likely to have a range of resources to hand so that they can respond dynamically to the students' needs. In contrast, when using Elluminate, resources such as whiteboard slides need to be pre-loaded. Tutors found it less easy to improvise, because it was difficult to make dynamic changes to some of the whiteboard slides. The tutors felt there was a need for "a repertoire of things to choose from". They commented that they would need to prepare new material for Elluminate tutorials, as the material prepared for face-to-face tutorials would not necessarily work here. The difficulties in improvisation reported here should decrease as tutors gain experience with the technology, as well as increasing their repertoire of teaching materials.

5.3. What are useful strategies for teaching via a web conferencing environment?

Web conferencing environments have complex, multimodal interfaces. These call for students to have the appropriate technical skills to enable them to interact in the environment. Tutors commented on the value of the separate Elluminate familiarisation sessions offered to students a few days prior to the tutorials.

Some tutors found it necessary to maintain control over the use of microphones. This was generally because of issues in audio quality but it also prevents participants talking over each other. Audio inputs can be managed by restricting the number of participants who can speak concurrently (for example, one open channel for the tutor and one for sharing between all the students) and/or by introducing a turn-taking protocol whereby students use a 'hands up' icon when they have something to say.

Technical problems or lack of suitable equipment can prevent some students from using audio, so making provision for this can be beneficial – for example, by encouraging these students to interact through the use of the text chat facility, yes/no icons and emoticons. However, when these tools are used simultaneously with speech, the need to monitor the text chat increases the number of tasks that tutors have to manage.

In the web conferencing tutorials conducted for this study, tutors were concerned with increasing student interaction – especially student-to-student interaction. There is some evidence to suggest that that student-to-student interaction is more likely to take place when the tutor is not present, so this could be encouraged by using breakout rooms.

5.4. What is required to support teachers, both pedagogically and practically, who are new to web conferencing?

Teachers need practice to build the skills, knowledge and confidence to support their students in web conferencing environments. Practical training and development opportunities are therefore very important. In our study, some tutors said that they needed more than the two training sessions offered. They suggested that further sessions could be practice sessions – perhaps with other colleagues. They also commented that they would appreciate some experience of being a student within the environment, so they would know how the interface looked to students.

All the tutors in our study appreciated the availability of resources (worked examples and activities for students) prepared specifically for use in a web conferencing environment. Tutors found these resources helpful, even though many of the tutors already had a range of resources used for equivalent face-to-face tutorials. Tutors who are new to web conferencing may not realise that some resources prepared for face-to-face interactions do not necessarily migrate well into online environments. They may not know what is likely to work, and how to make best use of web conferencing tools to encourage student interaction. As tutors gain experience, they can supplement or modify the prepared resources. One tutor commented on the value of sharing tutorial resources with other tutors, so an environment that enables this would provide an important support resource.

6. Web conferencing in subsequent presentations of the module

Following the successful trial of Elluminate web conferencing for numeracy support that is the subject of this study, similar Elluminate tutorials were introduced as part of the standard provision in subsequent presentations of the module (in 2010 and 2011). These involved all of the module tutors (approximately 140). As in the pilot study, tutorial resources were provided for tutors to adapt and use. The tutors were offered demonstrations of the tutorial resources within live Elluminate sessions hosted by one of the authors of this paper. Many of the tutors had also received training in Elluminate through other aspects of their employment with the UK OU.

Further support was provided for tutors through an online forum, and tutors used this to seek and offer help. This peer support included discussions on aspects of the tutorial content, as well as on usability and practical issues. There were also a number of comments relating to tutors' feelings of anxiety about using an unfamiliar tool.

In the forum, several tutors gave indications of their students' views, shedding further light on the first research question from the pilot study: *What are the benefits and issues of using web conferencing to support learning?* The following two comments provide examples.

"the thing that really impressed me is how enthusiastic my students were to be able to hear each other, and how much more personal Elluminate felt to them than the forum."

"Those students who came to the second session yesterday were very positive – most appreciated the chance to work through the calculations and ask questions; a small number found the numeracy element too basic, but enjoyed the chance to chat to fellow students."

Tutors also identified positive aspects of using web conferencing, compared to face-to-face tutorials. These comments were relevant to the second research question: *How does teaching via web conferencing compare with face-to-face teaching*? For example:

"For me one of the real benefits of Elluminate is that the preparation time is completely focused on the topics for the tutorial rather than logistics of how to get there etc."

"one of the two students who participated was in Albania visiting his family which rather proves the point that elluminate reaches the parts which face-to-face tutorials cannot reach."

Tutors also commented on their experiences of carrying out the tutorial activities. These comments revealed tutors' perspectives on the third research question: *What strategies are effective for teaching via a web conferencing environment*? For example, one tutor, commenting on her students' use of the shared whiteboard, said:

"Of course by writing on the board they got my attention more easily, but it also became a bit more collaborative – typically one student would start an equation, the next would finish it and a third would add the units. Then I would suggest another way of solving the problem or someone would ask a question … so on the whole an interesting experience."

There were also some comments on preparation for the tutorials. These comments help to address the fourth research question: "*What is required to support teachers, both pedagogically and practically, who are new to web conferencing*". For example, one tutor said:

"I don't think the preparation/training for this can be faulted, it's been fab, thankyou"

One of the tutors who had been involved in the pilot stage and then the large-scale rollout commented:

"Having used Elluminate for 2 years now I find it much easier, so I suppose like everything it helps to get lots of practice!"

7. Conclusions

The research reported in this paper investigated the experiences of tutors and learners who were new to using web conferencing in an educational context. The majority of the data were related to the tutors' perceptions and experiences. These were characterised by three main themes, summarised below.

Preparation and improvisation: The primary issue here was balancing the needs for prior planning and for real-time improvisation (Sawyer, 2004). Prior preparation and planning are particularly important for tutors who are new to web conferencing, so that they have a choice of resources to draw on during the live session, in response to students' needs as they arise.

Interaction and participation: The main challenge here was developing social presence (Short et al., 1976) so that the tutorials were interactive and engaging. Although students may initially be uncomfortable using communication media such as audio and video, these media can enhance social presence. Communication tools such as text chat and polling are also valuable and need to be integrated into sessions carefully so as not to discourage spoken interaction.

Usability and practical issues: A significant issue here was the cognitive overload (Chandler & Sweller, 1991) which can arise for tutors when managing multiple communication channels. The wide range of tools offered in web conferencing environments adds to the learning experience, but coping with multiple and parallel inputs from students is a challenge for tutors. As experience is accumulated, managing these multiple channels should become easier.

It is not surprising that the adoption of a new online tool requires training and support for tutors, and imposes an additional initial workload, but the degree of these should not be overlooked. It is worth noting that the tutors in this study were already skilled in distance teaching and online environments, but nevertheless experienced challenges when adapting their teaching methods to the new synchronous environment.

Using web-conferencing to conduct tutorials allows tutors and students to experience some of the benefits that are only otherwise gained from face-to-face sessions. It is a chance for interaction without the practical issues involved in travelling. The evidence from this study, and the subsequent successful rollout of web conferencing in the module, confirms the value of this technology, particularly in a distance learning context. As educators gain experience in web conferencing environments, many of the issues highlighted in this paper should be overcome, and the benefits more easily realised. At this relatively early stage, it is particularly important that the experience of teaching and learning via web conferencing is researched and discussed, so that good practice can be shared across the educational community.

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