Interactive audio in a lecture environment

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Abstract

This case study involves investigation into the use of wireless devices to interact with audio in a lecture environment. The main aim is to create an active, collaborative and interactive learning environment. Students use wireless game console remote controls to actively alter sound parameters in the lecture theatre, gaining instant audio feedback on their efforts. Evidence from a focus group suggests student learning was enhanced, and levels of engagement and motivation were raised. The possibility of transferring this activity to non-audio related subjects to facilitate student interaction is discussed.

1. Background

The main aim of this pilot study is the creation of an effective learning environment through the use of audio. The study involved a cohort of students from the BSc in Audio Technology with Multimedia and Electronics programmes in the School of Engineering and Computing at Glasgow Caledonian University. The majority of the students involved come from FE colleges directly into the third year of study. Typically the emphasis on the students’ education prior to that point is on acquiring practical skills in the area of sound production. One aim of the programme is to expand their theoretical and technical knowledge and expertise. As such, students encounter for the first time mathematical and engineering principles and theories which underpin the discipline, and many struggle with this change of emphasis. Students enrolled on these programmes are, in the main, audio enthusiasts. Over the years the programme team have observed that the students are at their most engaged with their learning when actively involved in creative activity resulting in audio output of some description. Towards this, practical laboratory sessions facilitate active experimentation and practical use of audio tools and software. Lectures, however, remain a main point of face to face contact with students with regard to teaching on specific modules, and in this typically didactic scenario there remains little ‘action’ on behalf of the students (despite introduction of group discussion, set tasks etc.). In addition, although efforts are always made to include sound examples of the theories being discussed as well as other multimedia content addressing preferences for perceiving information through different sensory channels (Felder and Silverman 1988), there is little in the way of active audio creation in the lecture environment. The aim of this pilot study was therefore to investigate a means by which students could interact with audio ‘live’ in the lecture context, aiming to:

- introduce some form of activity into this otherwise passive environment
- allow the students to interact with audio in this context
- introduce collaborative learning towards completion of a task which was set for the students
- do this in a way that is motivating and engaging.

Some inspiration has been taken from efforts to create interactive lecture environments such as those involving electronic voter systems (EVS – see Draper et al., 2002). Although the details of implementation differ significantly from these approaches, one of the main aims is the same: to increase levels of interaction during the lecture. In this study the aim is not for learners to interact with the teacher (as opposed to the aims of EVS), rather they interact with the audio environment. In addition, the aim is not to enhance the learning experience solely through the use of technology -
indeed there is little evidence of the benefits this brings. Rather the technology is used as a means by which the pedagogical aims of the study (creation of an active learning environment) may be achieved, using technology to achieve course design objectives which could not have been achieved in more ‘traditional’ ways (Anderson and McCormick, 2005).

The primary influence of the ASEL project upon this activity is the use of audio and technology in facilitating collaborative learning. The aim is to take this principle and expand the use of audio toward this goal. Audio is used in this study differently to the ASEL and Sounds Good projects in that an audio subject is actually being studied in the lectures and student interaction with audio in an active learning environment is the main goal. In addition, the ASEL and Sounds Good goal of enhancing feedback is also relevant in that students hear instant audio feedback on their efforts at implementing theories being taught in the lecture.

As audio specialists, staff preparation for implementing the study was at a minimum in that there was no need for acquisition of specialist knowledge in the area. However, technical hurdles had to be overcome to implement the ideas central to the study. These are discussed later in this case study.

2. Methodology

The lectures used for this case study cover principles of harmonic content, sound synthesis and the relationship between synthesis parameters and results in the time and frequency domain. This is an audio specific subject and the audible results of the phenomena discussed are of key importance to understanding theories of sound synthesis. During these lectures the students are introduced to the means by which sound may be synthesised by various processes. In the main, these processes are mathematical in nature and are controlled by fairly prosaic numeric values, functions etc. It has been observed in previous years that students have difficulty in linking the manipulation of these many abstract parameters with the resulting audible effects.

To allow the students to interact with the sound ‘live’ in the lecture, wireless remote control devices (Wii game console remote controls) are distributed throughout the lecture theatre and the students actively control parameters and synthesise sound by tilting, rotating and moving the devices. The Wii remote control devices communicate with the lecturer’s laptop via the Bluetooth communications protocol and Open Sound Control (OSC). Hardware and software requirements for the study were:

- several Wii game console remote control devices
- laptop with Bluetooth communication capability
- a software application which translates the movements of the Wii remotes into OSC commands
- audio software which can be controlled by OSC commands.

Lectures are delivered in two parts. The first part consists of the delivery of the relevant sound synthesis theory by the lecturer (with according use of multimedia content). In the second part, Wii remotes are distributed to several (up to six) students in the lecture theatre. Each of these controllers has been mapped to control a specific sound synthesis parameter in the audio software. The students were told which parameters they were controlling and then asked to recreate, as a group, a particular effect which had just been discussed in the lecture. The details of two examples are given here:

- in one lecture the emphasis is upon how complex sounds may be created by the addition of many simple sound elements of varying strengths. These complex sounds can be identified by the shape of their waveform (as one might see on an oscilloscope) and their frequency spectrum. In this case students are issued with the Wii remotes, told that they will represent individual sound elements, and are shown an oscilloscope, frequency spectrum and, of course, they can hear the sound created by their efforts. They then have to work together, applying theory they have just learned in the lecture to create a complex waveform of a given type by movement of their Wii remotes.

- in another example, the emphasis is upon subtractive synthesis. In this case sound can be made by controlling one simple sound source with the frequency content of another. A powerful feature of this technique is the ability to separately control the two sounds to create interesting aural effects. The example used in the lecture is to hand a microphone to one student and ask that they

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1 The ASEL project is being led by Will Stewart at the Universities of Bradford and project partners at the University of Hertfordshire. The ASEL project has developed, implemented and evaluated the use of audio within next generation technologies to support, enhance, and personalise the learner experience. http://aselproject.wordpress.com/
talk into it. Several other students are given Wii remotes and allowed to control aspects of the student’s voice as he or she speaks into the microphone. One popular example is the ability to make the student ‘sing’ by altering the pitch of what they are saying as they speak.

In each case, the activity in the lecture theatre is directed toward illustrating two or three key theoretical points raised in the preceding talk delivered by the lecturer. The students actively control the parameters which had been identified as being key to producing particular aural effects. Also, each case requires that the students in possession of the Wii remotes communicate and collaborate with each other to achieve the desired result. The result is of course instant and audible.

3. Issues

The technology used in this study is not simple to use, however it is not prohibitively complex. A key point is the support for communications between devices and software being used in the lecture. Most Laptop computers support Bluetooth communications. If they don’t, this capability can be gained by using an inexpensive USB ‘dongle’ which attaches to the laptop. The Wii remote controls are also inexpensive. In this case, GlovePie (Kenner, 2009) was used to translate the controller movements to OSC. GlovePie is for use on PCs and is free of charge. On Mac platforms, the program OSCulator (OSC, 2009) does the same job and the evaluation version comes free as part of the Mac operating system. In this study, Native Instruments’ Reaktor was used to actually produce the audio. This program supports OSC and all the sound synthesis functionality required in the audio subject being taught. Reproduction of the activity described in this case study requires that these communications and compatibility issues are addressed. One interesting issue is that students must be asked to switch off their mobile phones if Bluetooth is enabled, as these can interfere with communications between the Wii remotes and the software.

This technical arrangement takes time to set up. Typically, the software and remote devices can be set up in five to ten minutes prior to the lecture starting. However if it is required that the configuration of the software and remote devices is be changed during the lecture, this can take a few minutes and interrupts the ‘flow’ of the activity. In this case study a second member of teaching staff assisted in this task.

4. Benefits

In previous years, it has been difficult to engage students’ interest and enthusiasm when teaching parts of the subject taught in these lectures. This seems to be down to the difficulty of linking abstract mathematical functions or control parameters to the resulting audible effects. Although the practical laboratory sessions allow students to experiment with these parameters, the lecture is the first time they encounter these ideas and it is important that the students achieve an intuitive understanding of the subject being taught from an early stage. Each of the tasks the students are set is aimed at concreting or illustrating a specific theoretical point presented in the preceding traditional slide-based section of that lecture. Thus the aim is not that they simply ‘mess around’ with the remote devices and create abstract sound, rather that they work together to create a certain effect discussed in the lecture. The activity involving the Wii remotes certainly enthused the students and their enjoyment of the exercise was apparent. The lecture room atmosphere was instantly more lively and students intimated that they had really enjoyed the experience.

Staff time is not saved in this activity – indeed that is not the aim of the study. Rather the fact that the students are themselves interacting with the audio environment frees the tutor to move around the lecture theatre and actively discuss and describe the audible effects of the students’ actions as they happen. The audio produced represents instant feedback for the students on the results of their actions and these results are actively discussed as they are being created. This felt like a much more beneficial situation than the tutor simply altering a few parameters and describing the resulting effects. The actions of the students sometimes created unexpected audible results, leading discussion down a different route than the lecturer may have planned.
5. Evidence of success

A focus group to elicit student views and experiences of the pilot project was held with five participants. This was facilitated by a researcher who was not part of the teaching team and did not know the students, other than having been an observer in the last of the lectures. Observation in class by the lecturers and the researcher found that the level of engagement displayed by the students in the first half of the lecture and the second half (where they are tasked with creating sound by using the Wii remote controls) was immediately apparent. Students start smiling as they hear the effect of their input, they start to chat to each other, sometimes being told by their peers what to do next to achieve a certain sound effect, collaborating with the other students who have a remote control with the aim of creating the desired results etc. In one particular example, there was even a round of applause from the students when those who had the Wii remote controls successfully managed to recreate a complex sound discussed in the lecture.

During the focus group the students showed great enthusiasm for the use of this technology in their lectures. They were actively aware of the pilot and had clear views on what they saw to be the benefit of the technology to them. They discussed it in terms of the overall lecture experience, how they felt it helped their understanding of the subject, as well as giving views on how it may be engaged as a tool in other areas, both within their own subject and within other disciplines.

‘Yes it is a brilliant learning device plus if I go back to what [X] was saying about the effort that [the lecturers] put in, that also encourages us to learn because you could see the effort and perhaps even passion that these two guys are putting into teaching and it sort of encourages us to put the same into learning as well.’

The students discussed how the technology made the lectures ‘more interesting’ and how it seemed to encourage more students to attend. They liked the ‘visual feedback on what was happening with the remotes’ and how this fitted with their discipline as being ‘creative sort of artistic thing and a lot more hands on.’

They felt it helped their concentration, for example here they discuss their more traditional lectures and the problems of sitting for a long time in a passive environment:

‘Especially like, our lectures were at this time [1pm] and the room it is hot […] There was loads of people in it and it was really hot and it was a Thursday afternoon and you were just like…’

‘Dropping off to sleep?’

‘You were but with that [the Wii remotes] you kept awake and everything. You actually engaged and learned stuff.’

And here they discussed a more immediate outcome:

‘I think concentration wise because [the lecturer] didn’t […] say ‘I will show you what to do’ and then do it on the screen. It was ‘who wants to have a go?’ and hands up volunteers at first. It brought you back into it, got you a bit more awake again. So you stop having to concentrate for so long on one thing, just watching the board and watching him change things.’

‘It was a lot more engaging because of the novelty as well plus personally it made you want to concentrate more on what was happening in the lecture because you could get picked out half way through to actually drive the thing and if you weren’t concentrating then it would be a mess so it sort of encourages you to pay attention rather than just fall asleep.’

Informal student feedback suggested that, besides enjoying the experience, they felt it clarified points that they simply didn’t grasp before taking part in the activity. In the focus group they made very clear connections between use of the device and the theory and how it helped them to link the theory in the lectures to the practical in the labs:

‘It means that you understand it so that when you go into the labs you can go ‘right well I can do this’ whereas if he just showed you how to do it you would be like ‘aye alright’ but by the time you come to the lab you just would be like – how did he do it? But if you are either doing it, people are doing it with the Wii remote, you learn it.’

‘[The lecturer] went through it all, [the theory] and at the end we were using the remote to actually see what the parameters did, what the effects were.’
They went on to discuss how it helped their understanding by learning from their mistakes, rather than passively accepting the ‘perfect’ answer shown to them in the lecturer:

‘Yes we would have had to have taken it as read [...] that’s what you do, that’s what it’s like, you learn something but you don’t [...] just take his word for it.’

‘[…] you can see when things go wrong why they went wrong and then you need to tweak it and you got from the mistakes you learned why that parameter does that effect.’

Personally using the devices was viewed with mixed feelings. Whilst the students very much enjoyed the intervention, they felt that being the one to use the Wii may potentially be disadvantageous:

‘I used it yes and personally I preferred not to use it. Not that I wasn’t interested in using it but when you are using it you are sort of concentrating more in what you are doing than what you are taking in.’

The student though then went on to say:

‘[…] while you are using it you are also sort of getting hands on, it is quite difficult to explain but when you are using it, like operating it yourself you are concentrating more on what you are trying to do rather than listen to the overall effects.’

‘I’d try it again because there is always a difference between watching other people do something and trying it yourself.’

The activity was also aimed at facilitating two-way discussion between learners, their peers and tutor and linking to related and relevant concepts (White, 2001).

‘It is a bit of communication between other students like in the lecture hall because they are used to like sitting in the lecture hall in silence but when you have got people trying work together to achieve this, it sounds corny, but this common goal then you communicate with each other. It sort of brings you together.’

The students valued this aspect of the lecture. They are used to helping each other when in the labs and enjoyed being able to bring discussion into the theory lectures.

‘[…] if one person didn’t understand and somebody next to you did, you would ask and bounce off each other. If somebody would know something and somebody would know something, you would bounce off each other to understand it properly. In the labs […] the lecturer he is showing you how to do the stuff and in the labs you actually do it.’

‘Because the labs are examples of what we did in the lectures. We would all do something completely […] they all tied together.’

They went on to discuss it as a potential ‘ice breaker’ activity at start of the semester, but this would require further investigation.

‘I don’t know if it would have worked as well just at the start of semester […] if they had done it at the start when everybody was new to each other, I don’t think […] I don’t know.’

Although the signs of increased motivation and engagement are instantly clear, it is important that these alone should not be taken as a sign of increased learning. The focus group gives us an insight into the students’ view of an increase in their learning, but this requires further study to compare grades and exam results.

Some final thoughts from the students were about the intrigue of using a technology for a purpose other than that which it was designed for and the potential of this technology for other disciplines:

‘It is seeing it in another application makes you think, because especially with us, some of us will be going onto honours projects and that’s the kind of thing you can develop as part of your honours […] sort of using things that are may be already there but changing their application so you can use them for more sort of sectors for whatever industry that they were designed or not even designed but can be used for.’

‘It is an excellent selling point for the course as although you have got to be aware it wouldn’t work on every sort of subject […] I couldn’t see you using it in an Accounting degree or whatever using a calculator with a Wii remote.’

‘Teaching medical students how to perform surgery with it?’

‘The emotion has to match what needs matched physically.’
6. How can other academics reproduce this?

Staff teaching audio-related subjects can easily recreate the activity carried out in this study by implementing the aforementioned hardware and software. Any parameter of suitably enabled audio software can be utilised using this technique. Examples may include use of multitrack sound production software to allow students to create a ‘mix’ during the lecture, or use of sound spatialisation to allow the creation of a surround sound environment in the classroom. Likewise, given the presence of the required software and hardware communications capability, tutors can allow students to control any parameter of any software package being taught in their lecture – whatever their discipline. However this obviously comes without the implicit use of audio feedback.

Outwardly, one might expect this activity to be relevant only to those teaching audio subjects. However, there exists an interesting possibility for the use of data sonification – the use of non-speech audio to convey information (Hermann, 2008). Typically sonification is compared to visualisation, the aim of both being to clarify patterns in data, highlight relationships between data and systems etc. Just as we use graphs, tables and images in lectures, we can use sound to aid understanding of what we are trying to teach. For example, research has shown that sound can be used to aid understanding of statistical features such as trends and correlation (Flowers et al., 1996). This may be an interesting area for future research: the use of sonification techniques combined with wireless student interaction to allow the use of interactive audio in lectures for any discipline.

7. Reflections

This was a learning process for those involved. Initial results for this pilot study were rather unpredictable in the sense that one of the main aims of the activity – the emphasis of a particular theory or point from the preceding talk - was not as clear as it could have been. This was due to the level of activity and unpredictability of the students’ actions. Later sessions were organised so that the activity was broken down into a series of smaller tasks, each structured around one particular theoretical point or idea. This seemed to run more smoothly, and the point emphasised more clearly. However the structure was not so rigid as to inhibit experimentation and the possibility of students influencing the direction of the lecture.

Some evidence of ‘novelty wearing off’ was apparent after the first week, with an according drop in apparent enthusiasm. However, levels of engagement seemed to be sustained throughout the duration of the study (three lectures in total) and students stated they felt as though their learning had benefited in each session. Care was always taken to ensure that the pedagogical aims of the activity were the main focus. Future implementations of these techniques must take similar care.

The setup time and technical considerations could, if not subject to careful preparation, be an obstacle to successful interaction in the lecture environment. It is possible that teaching staff may get themselves into a position where they have to pause and concentrate for a few minutes to set up the system. This interrupts the overall flow of the lecture and can be a bit nerve-wracking for the lecturer.

We shall certainly continue to use and develop these approaches in teaching audio subjects to our students. The transference of these techniques to other disciplines, and the use of audio to underpin them, may be investigated by using the aforementioned sonification approach. Whether or not this is a useful tool in teaching other subjects is a matter for future research.

8. References


