

## Blending the Engineer's Learning Environment through the Use of Audio

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**Abstract:** *A blended approach to learning, teaching and assessment has been part of curriculum design in the teaching of Software Engineering to engineers since 2003 when the Blackboard VLE was first used alongside lectures and laboratory-based assignments. In seeking a greater degree of integration between physical and virtual learning spaces we have been keen to explore how digital audio can be used to engage and develop students. Digital audio has shown itself to be a simple media with which to work and a simple media to distribute. Its essential value has proven to be in how it supports access to the disparate voices available to education and we have developed several ideas. These include Audio Notes to support lectures, educational podcasting and audio feedback to bridge the virtual and physical environments towards offering a more meaningful, richer, and formative learning experience. Our recent work has proven that digital audio is generally accessible to, and valued by students, and that it can lead to greater ongoing engagement in the module. This paper focuses on the formative feed forward potential of this flexible media and illustrates how we have built upon initial successes by improving the design and integration of audio feedback. It describes how the techniques have been used to promote an holistic blended learning environment and how this has affected both the student and the tutor.*

### **Introduction - the imperative for innovation in blended learning**

A blended approach to learning, teaching and assessment (LTA) has been part of curriculum design in the teaching of Software Engineering at Sheffield Hallam University since 2003 when the Blackboard Virtual Learning Environment (VLE) was introduced to complement lectures and laboratory-based assignments. Yoon and Lim (2007) describe blended learning as "a purposeful mix of delivery media (particularly face-to-face and various forms of technologies) to improve learning/performance." Rossett, Douglis, and Frazee (2003) recognise that an integrated blended learning design strategy focussed on the aims of the learning is needed. Definitions of blended learning are diverse - some are technically oriented, whilst others are more concerned with the mix of people and their access to each other (Yoon and Lim, 2007). This paper considers the use of audio in higher education, in particular audio feedback, that both makes use of the extended technological environment whilst at the same time promoting learner access to tutor voices.

The potential of the VLE as an engaging learning environment is often neglected it can be much more engaging than its frequent use as a simple lecture note repository would suggest; it can be an extended learning space supporting a range of engaging, blended learning methods that together contribute to forming an holistic strategy of integrated physical and virtual spaces, tools and materials. Its effective, blended use

inevitably leads to, and is informed by, a change in practice through academic innovation.

The new extended and blended paradigm for LTA offers a rare opportunity for academics to find and devise more effective methods of engaging their students. Digital audio has proven to be a wonderful medium to consider in this new era of blended learning because it is simple to use. Mobile recorders and mobile players enable us to easily make media-facilitated interventions (Bradley *et al.*, 2006) that challenge and encourage our students and guide them by bring learning voices to the fore.

### ***From lecture recordings to audio lecture notes***

Commentators continue to debate the efficacy of recording lectures and making the recordings available from the VLE. The debate is salient in understanding why engaging with blended learning properly is so important.

Initial concerns amongst academics were that the practice of recording lectures may impact upon lecture attendance. However reports from Law (2005), Williams and Fardon (2005), and Russell and Mattick (2005), as well as others, claim that attendance is not affected. For some like Law (2005) the burden of managing the production of such recordings is time consuming, whilst in other cases systems have been put in place to deal with the planning, recording and distribution issues. However, perhaps the most important area for debate should be concerned with whether new technology is best deployed to reinforce a teaching method that historically emerged according to the constraints of a bygone era or whether technology should challenge academia to explore and develop new, less constrained, digital and blended pedagogies.

Each of the above cases found that students only wanted to access small segments of the recordings to help them clarify information or reinforce understanding around specific points. As a consequence the authors developed a different approach where short 'audio notes' were captured with an MP3 device by the academic in the course of the lecture (Fidler *et al.*, 2006). The audio files were then labelled and distributed via the VLE. They reported that the stakeholders associated with this approach (students, academics, student support, librarians, and technical support staff) felt such recordings offered excellent supplemental module learning resources: working with short clips gave the student more control, allowing them to interrogate the audio more easily and when they were ready to re-engage with the content. In this model students are not expected to listen to the whole lecture again, rather they use the recordings as and when it suites them.

This research also revealed that when students played back the audio notes they said they were able to reconnect to their train of thought from the original lecture; according to some respondents re-hearing a phrase, a student voice, or a door slamming in the background, triggered memories of their original experience. If audio can provide a mechanism for re-engaging with subject matter, and personal construction around that subject matter, then perhaps a similar reconnection could be found in lab-based tutor-student assessment conversations.

A blended learning approach has the potential to increase the number of 'learning layers', or encounters, with the subject matter enabling students to deepen their learning through iterative exposure. In an interactive lecture, figure 1, the lecturer and students can converse and engage there and then with the topic in hand. By adding audio lecture notes to the VLE, figure 2, a new cycle of engagement in the content is enabled. The interactive lecture model still offers greater opportunities than those

offered by the traditional, simple monologue model of lecturing, (Nortcliffe et al 2002), as there is little opportunity for the student to check their understanding or for the lecturer to check the student's comprehension. Making the previous year's audio lecture notes available through the VLE prior to and after an interactive lecture advances a more complex, multi-layered, cyclic learning resource that can enhance and deepen the student learning experience around a subject, figure 3. Because content is being recycled the academic burden is reduced. This model of learning is not dissimilar to the concept reading around a subject prior to and after the lecture.

The technique can be thought of as *prevision, vision and revision*. This paper proposes that making audio lecture notes available prior to and post lecture is a more student-centred approach and indicative of the benefits in taking a blended learning approach to curriculum design.

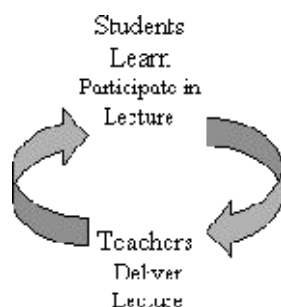


Figure 1 Simple Cycle of Learning in an Interactive Lecture model

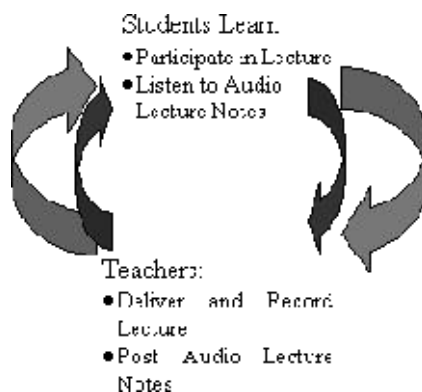
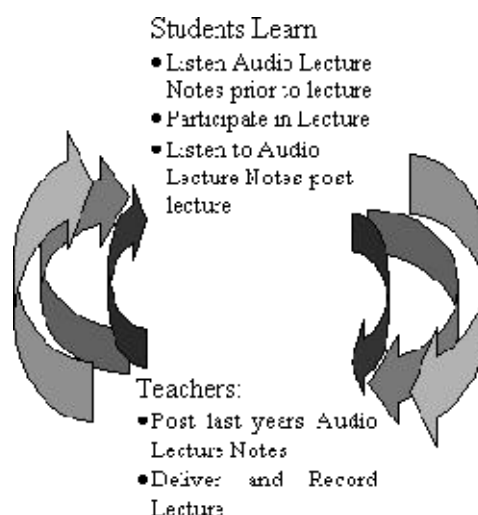


Figure 2 Cycles of learning with posted Audio Lecture Notes



**Figure 3 Complex Cyclical Model of Precede and Proceed Audio Lecture Notes**

### **Audio feedback**

The purpose of feedback is to provide a formative experience for the student, actively engaging them in deciding what they need to do in order to progress (Sadler, 1989). Therefore when technology is introduced to the feedback process its purpose should be to promote formative engagement. This is best done by improving prompt access to harness the formative capacity of assessment enabling students to quickly focus on improving in areas that are weak (Chickering and Ehrmann, 1996).

Audio feedback is not new. Early research into audio feedback predates the introduction of VLEs and digital technology, however Moore's (1970) studies with analogue audio feedback indicated that the students preferred audio feedback to that of written feedback, and the production of audio impacted less on the academic than the equivalent written notes. Other academics, for example Kirschner *et al.* (1991), have been impressed by the power and the results of audio feedback for encouraging student engagement in learning. Johanson (1999) highlighted that for students studying English as a second language analogue audio feedback was indispensable in feeding personalised feedback forward into future assignments. One of the potential drawbacks of this approach of tutor recorded analogue audio feedback, as defined by Takemoto (1987), is that it provides no opportunity for student-tutor interaction. However, Kelly and Ryan (1983) reported that British Open University students still liked the audio feedback provision as it provided a degree of personal contact, and a better critique and review of their assessment submission than would ordinarily appear in the tutor's written comments.

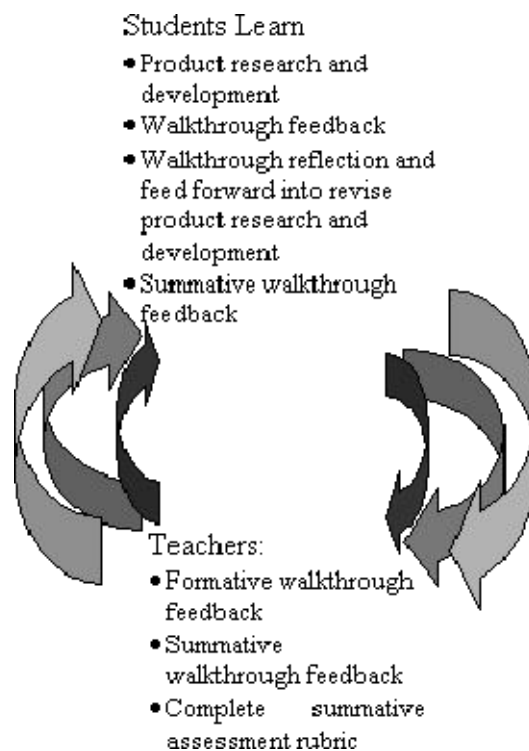
As Rust (2001) noted, the voice is able to convey more than mere words: the tone, nuance, expression, informal language, sincerity and the evidence of personal, dedicated input from the academic, provides additional layers of meaning and feedback to the listener; attributes that are hard or impossible to reliably convey with other media. Good feedback should, "foster positive self-esteem" and encourage students to act upon the feedback (Young, 2000). The care of student self-esteem is a sensitive business; feedback that is perceived as harsh by the student can be extremely damaging despite the best intentions of the tutor. Audio offers the tutor channels for the communication of feedback that are particularly appropriate as intention can be more easily conveyed through the way the feedback is expressed.

Rotheram (2007) found that the digital audio revolution had made it possible to fulfil Rust's (2001) pastoral aspirations for audio feedback whilst satisfying external examiners' requirements for quality assessment feedback.

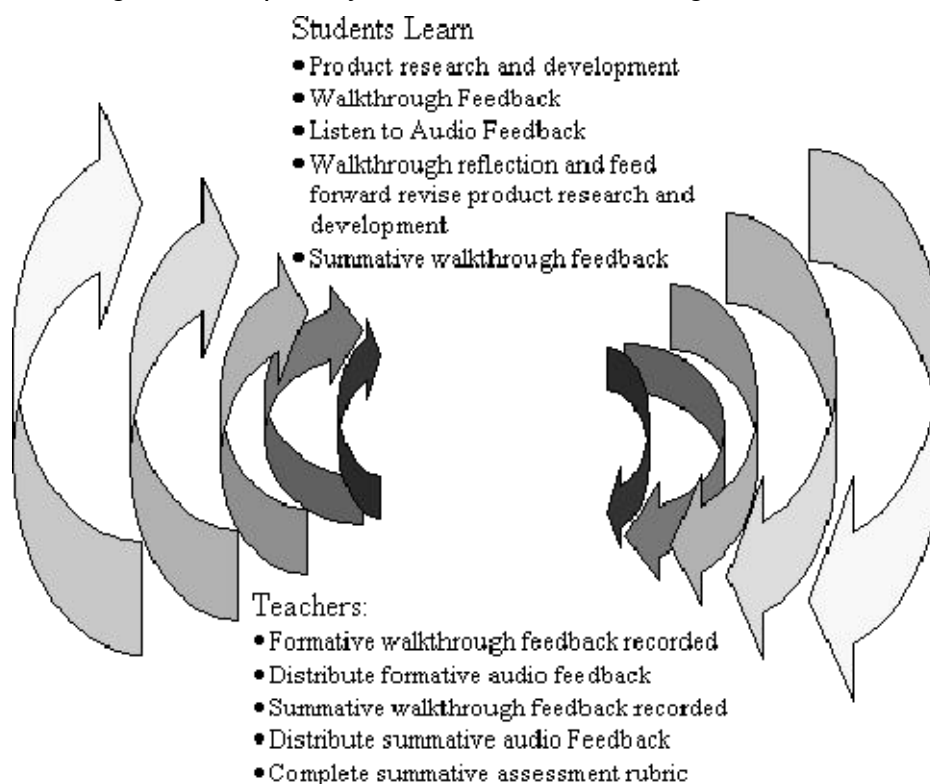
Takemoto's (1987) concern that audio feedback delivered a one way conversation can be resolved in the personal conversational audio feedback model described by Nortcliffe and Middleton (2007) who reported that this method of recording student-tutor formative conversations in the lab captures not only the tutor's voice, but also the students. Furthermore, Middleton and Nortcliffe (2008) note that the value of timely feedback is less about the speed with which the feedback can be administered and more to do with the student's control in determining when it would be best for them to listen back to it, and that in some cases this may be hours, days, weeks or months later. In this way the recording of lab-based conversations ensures that the learner's construction of knowledge through effective feedback is not obscured by time and enables the student to successfully feed forward their learning into their ongoing work.

Audio feedback can be seen as a media intervention: its purpose is to affect learning rather than to transmit knowledge (Bradley *et al.*, 2006). There are many models of audio feedback; as well as the personal conversation model described here, there are generic broadcast approaches (Middleton and Nortcliffe, 2008), tutor directive approaches and peer and self-assessment approaches. Each of these approaches may be modified by their timing and by the accompanying techniques (e.g. assessment grids) and context with which they are deployed. Duration, speed of deployment, and method of delivery are examples of other facets that may affect the nature and effect of the feedback.

A student demonstrating their work or walking the academic through their assessment can receive timely formative feedback in the lab (walkthrough feedback). This can promote student reflection and feed forward action, leading to improvement in the student's submission, figure 4. However, the potential impact of this valuable formative conversation decreases with the passing of time as the feedback conversation becomes a vague memory (Middleton and Nortcliffe, 2008). The provision of recorded personal audio feedback conversations therefore should enable students to refresh their memory of the conversation and re-activate their train of thoughts (Nortcliffe and Middleton, 2007) and to promote new layers of engagement through the feedback. The role of recorded feedback in this formative assessment process has the potential to evoke a complex ever increasing cycle of deepening learning, figure 5.



*Figure 4 Complex Cyclical Model of Walkthrough Feedback*



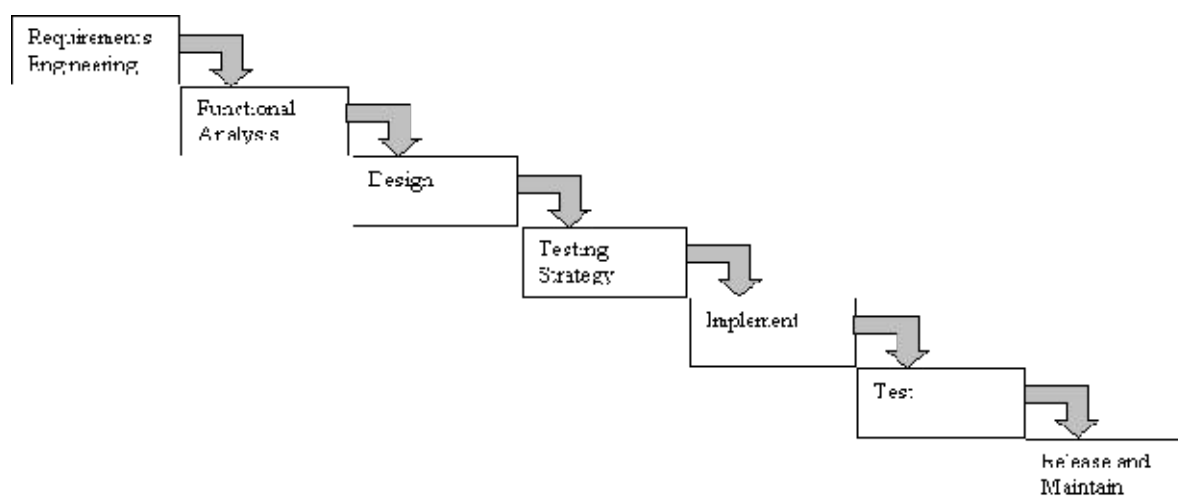
*Figure 5 Complex Cyclical Model of Audio Recorded Walkthrough Feedback*

Software engineering projects lend themselves to audio feedback whether the project has an academic or professional context. Sommerville (2004) explains that the review process is a valuable part of any individual or group software project in research and development. It offers an effective method of picking up problems and

improving systems. The audio recording of the walkthrough review further aids the process of feeding forward and so improving upon the previous stage's work. Audio feedback has the potential to assist all parties involved in a software engineering project to ensure all parties have a comprehensive understanding and record of the walkthrough. The record will assist with the data formulation and generation at each stage of the project leading towards a satisfactory conclusion, i.e. the right product is produced to fulfil the user requirements (Sommerville, 2004).

### **Methodology**

A heuristic blended approach has been developed to teach software engineering to Electrical and Electronic Engineers, whereby the module delivery and application replicates the flow of the waterfall software engineering project lifecycle, derived from the system engineering process proposed by Royce (1970), figure 6.



*Figure 6 Waterfall Software Engineering Lifecycle Model*

The learning, teaching and assessment flow together through the same process stages of the software engineering project lifecycle with time used to progress the assignment in each lecture and laboratory according to the lifecycle. The lectures are primed by last year's audio lecture notes made available one week beforehand using adaptive release in the VLE. This complements the posting of the lecture PowerPoint slides and other written materials.

The students undertake a Software Engineering project that involves them in researching, designing, and simulating a simple robot, with each cohort assigned a different type of robot. The students walk the academic through each stage of the project in each laboratory demonstrating the flow of the project from one stage to next. The walkthrough also provides the opportunity to feedback on each stage of the project and promotes reflection on the impact of each stage to those that have preceded and those that follow. This process is akin to the iterative feedback waterfall software engineering lifecycle model, figure 7.

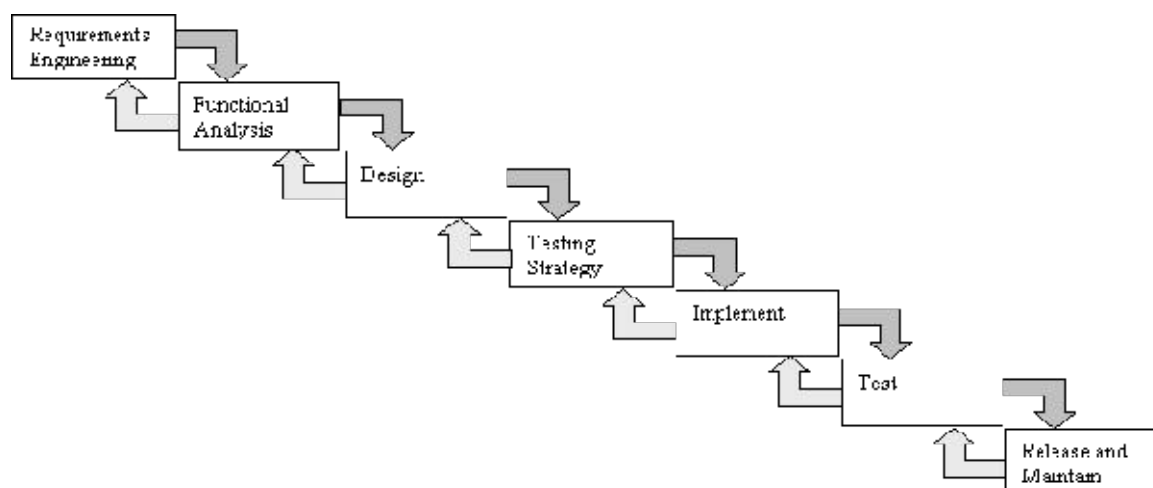


Figure 7 Waterfall with Feedback Software Engineering Lifecycle Model

Each student-tutor walkthrough feedback conversation was recorded where possible using a portable device. The recordings were distributed through the Blackboard VLE and when this was not possible due to equipment failure, the academic reflected on the lab-based walkthroughs and recorded appropriate audio feedback distributing it in the same way. An earlier study had indicated that students preferred conversational feedback to audio comments recorded by the academic in isolation (Nortcliffe and Middleton, 2007). The rationale for recording the conversations was that it provides an opportunity for the students to make stronger connections to the feedback, reflect on their own contribution to the walkthrough conversation, and to feed forward the feedback into improving the project progress. The assignment is concluded by completing the software engineering life-cycle module journey with a summative walkthrough of the system at the end of semester. Finally, students undertake an electronic multiple-choice question (MCQ) phase test in the VLE to conclude the module and to measure the student learning against learning outcomes. The module in question is a 2nd year (level 5) core semester-long software engineering module taken by students enrolled on an Electrical and Electronic Degree Course.

- 2006/2007 cohort consisted of 5:4 split of full to part-time students. One full-time student was female, otherwise all were male.
- 2005/2006 cohort were all male in a 3:4 part-time to full-time student ratio. However the formative and summative lab-based walkthrough conversations were not recorded for this cohort.
- 2004/2005 cohort consisted of 7:10 ratio part-time to full-time students with two full-time female students. They received no audio feedback or audio lecture notes.

### **Module Reflections**

#### **Audio Lecture Notes**

The response rate to the survey was 86% for the 2005/2006 cohort, table 1.

Questions	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Not Applicable	Unanswered
I have used the audio notes		6		5			1
I regularly used the audio notes	0	3	2	2	2	2	1
I have used some of the audio notes	0	5	1	0	4	1	1
I used the audio notes prior to the lecture		2		4		4	2
I used the audio notes post the lecture		4		4		2	2
I have used the audio notes for revision purposes		1		5		5	1
I found the audio notes helpful	0	4	3	0	2	2	1
I have learnt from the audio notes	0	3	3	0	2	3	1
I like the audio notes as lecture chunks (number of files)	0	4	2	2	2	1	1
I would like lecture audio notes as one file	0	3	4	1	2	1	1
The quality of the audio notes is satisfactory	0	6	2	0	1	1	1
The audio notes are easy to search	2	4	1	0	1	3	1
I would like the audio lecture notes to be podcast	0	3	3	0	2	2	2
I would subscribe to a site, to receive a podcast of the audio lecture notes	0	4	2	1	3	1	1
I would like board drawings recorded in future	3	5	1	0	1	1	1

Table 1: Cohort 2005/2006 Survey response to Audio Lecture Notes

The survey results for 2005/2006 indicate half of the survey respondents used the audio lecture notes, though not regularly. Responses to using the lecture notes correlate with the results survey on the way audio lectures notes were used post lecture and for revision purposes. Students who used the audio materials found them useful, were happy with quality, and found them easy to search as segments, whether they accessed them before or after the lecture. The audio lecture notes are no more than 10-15 minutes long and clear file-naming was used, correlating to relevant sections in the lecture handouts. The only products from the lecture that were unavailable in the VLE repository were the whiteboard drawings; the survey results indicate these would be welcomed. One respondent commented that, "The combining of audio notes to slides would be good, maybe animation of constructing diagrams would help too."

Another appreciated, "the ability to preview what the lecture was about," and this is further reflected in the survey results.

The 2006/2007 cohort response rate to the survey was 71%, as illustrated in table 2.

Questions	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Not Applicable
I regularly used the audio notes	0	2	3	6	3	0
I have used some of the audio notes		5		6		1
I used the audio notes prior to the lecture		1		8		2
I used the audio notes post the lecture		3		6		3
I have used the audio notes for revision purposes		2		6		4
I found the audio notes helpful	1	2	5	0	2	2
I have learnt from the audio notes	0	3	5	1	1	2
I like the audio notes as lecture chunks (number of files)	0	5	4	1	1	1
I would like lecture audio notes as one file	0	2	3	4	3	0
The quality of the audio notes is satisfactory	0	4	4	1	1	2
The audio notes are easy to search	2	2	2	5	0	1
I would like the audio lecture notes to be podcast	1	3	5	1	1	0
I would subscribe to a site, to receive a pod cast of the audio lecture notes	1	3	3	2	3	1
I would like board drawings recorded in future	5	4	2	0	0	1

Table 2: Cohort 2006/2007 Survey response to Audio Lecture Notes

Uptake of this resource was less than in the previous year with less than half using it, and on an irregular basis. Several respondents highlighted the value of the approach to them,

"Good for quick revision and understanding."

"They were helpful in giving an overview of the work covered in the lecture and provide support to the notes."

However some students had not appreciated the value of audio lecture notes. One respondent clearly indicated a dislike for audio-based learning as a mechanism for transmitting knowledge,

"I personally don't like the MP3's. They are slow and harder to understand than plain MS Word documents. I think I could have learnt more from reading."

The same student said, however, that they had used the audio to help them develop their knowledge of a particular topic.

The survey results from this cohort indicated that just one student used the audio lecture notes prior to the lecture,

"I used the notes for the first lectures; when the course first started, I used them to learn [for] the next lecture to get a feel for what to expect."

The majority of respondents indicated that the chunking of audio lecture recordings was preferable to a single audio lecture file. This cohort agreed with the previous cohort with regard to their interest in having the whiteboard drawings captured and available in the VLE.

**Audio Feedback**

Questions	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Not Applicable
I have listened to the audio feedback file(s).		8		3		1
I prefer recorded formative audio feedback to audio feedback in the lab.	1	2	8	0	1	0
I prefer recorded formative audio feedback to written feedback.	0	1	6	0	4	0
I found the recorded audio feedback helpful.	3	3	3	2	1	0
Recorded audio feedback helps me to clarify what actions I need to take to improve.	3	5	2	0	1	0
Recorded audio feedback helps me reflect on my learning.	0	4	4	3	1	0
Recorded audio feedback helped me to improve my assignment submission.	3	3	0	5	1	0
I would like recorded audio formative feedback provision to be provided in other modules.	3	2	4	1	2	0

*Table 3: Cohort 2006/2007 Survey response to Audio Feedback*

There was a survey response rate of 71% for the 2006/2007 cohort. The survey results indicated that the majority of students accessed the audio feedback and found it helpful (table 3). Some indicated through comments that they personally valued the audio feedback resource far more than the audio lecture notes,

"What a result it was - really helped with my assignment! Miles better than audio lecture notes, they were pointless."

The majority of students indicated a preference for written feedback, but valued audio feedback in lab as well.

"First time I have come across this and found it very useful, could do with audio and written feedback as well."

"Both written and audio feedback made for good assignment feedback."

The results also show that students valued the audio as a way to help them clarify how they could convert the feedback into actions towards improving their submission. Students regarded audio feedback as a valuable memory bank, ready and waiting for them as and when they needed to revisit the guidance,

"It is very useful as it was a hard copy of what was said and reminder. It could be used at a later date and helped to improve the assignment. Definitely a system which should be continued to be used in future."

"I found the assignment feedback useful as I could look back at what was agreed in class."

The survey confirms that some of students would appreciate a similar approach in other modules.

### **Module Academic Results**

<b>Phase Test</b>	<b>Ave</b>	<b>Std</b>
Cohort 2006/2007	48%	2
Cohort 2005/2006	55%	2
Cohort 2004/2005	41%	2

*Table 4: Class Phase Test Results*

Table 4 shows that the provision of audio lecture notes significantly contributed to the facilitation of student learning, given the survey's indication that about half of the students had used the resource. An improvement of 15% can be seen by comparing the cohort 2004/2005 (no audio lecture notes) to 2005/2006. However the phase test results for 2006/2007 are poorer, table 3, and this correlates to the student survey results, table 2, in that the majority of students found audio lecture notes less helpful and not as easy to search. This may indicate that the resource was under utilised because its value was not appreciated.

<b>Software Engineering Project</b>	<b>Ave</b>	<b>Std</b>
Cohort 2006/2007	53%	13
Cohort 2005/2006	60%	9
Cohort 2004/2005	63%	9

*Table 5: Class Software Engineering Project Assessment Results*

The class average for the Software Engineering project, table 5, indicates that audio feedback had little detrimental effect on the assessment results in a class of 17 where two students were referred. The results concur with other observations (Nortcliffe and Middleton, 2007) on a Software Product Development and Maintenance assignment, where the provision of audio feedback on its own had had

a detrimental effect on the class grades because only 39% had used the resource and, without any written feedback, the formative feedback opportunity was lost. In the case considered here approximately half of the class used the audio feedback in combination with short written comments. This combination of feedback methods is obviously more useful and some students clearly valued the audio feedback,

"I just did the basic minimum when I used to go into class and she'd tell me where I could improve stuff....because it's such a long project, again I left it til quite late on to get on with it - 7 or 8 weeks. It was handy to go back and listen to what she'd said earlier on. How I could improve myself."

"It upped my grade. Upped my grade from a 60% to over a 70% for that project. I was looking at 60% without audio feedback. With audio feedback it pushed me back into a 1st."

The implication is that the audio feedback raised the class average. One student advised next year's students,

"Make use of it. Don't forget it is there or come back to it at the end of the year .. keep it fresh."

Student referrals provide another measure. In the 2004/2005 cohort there were two, none for 2005/2006, and two for 2006/2007, with all referred students passing on their second attempt. The referred students from the 2006/2007 cohort readily accessed the audio lecture notes during the referral period to assist them in developing their understanding of the subject matter for Software Engineering project assessment. In addition both students were provided with formative feedback sessions during referred assessment period and these were audio recorded and distributed back to them via the VLE. One student explained why they valued the audio feedback,

"I have got a pretty bad memory as it goes, so it was nice to go back and listen to our conversation again, have another listen to what was suggested."

### **Conclusion**

The phase test and survey results, though from a small sample, indicate that when audio lecture notes are used by the students, they can have a positive impact on their learning and engagement with subject knowledge. The audio lecture notes can support a deeper understanding of the theory and its application as evidenced in the multiple-choice phase test results. When the students did not engage with the audio lecture notes the class average for the phase test went down in comparison to the previous cohort who had demonstrated greater engagement. Student engagement with the audio lecture notes dropped on the introduction of the audio feedback indicating either a preference for the latter, reluctance to use generic audio, or confusion over the relative purposes of the media. If audio lecture notes are used their value will be increased by clearer integration into the teaching.

The findings from the evaluation of audio lecture note distribution are mixed. Lecture recordings were presented as chunked notes in order to facilitate selected access by students to subject content and discussion. The intention therefore was to offer media interventions - media that could affect student learning in a timely way, as determined by each student. Again, as an emerging practice, it is suggested that the value and application of the resources could be more clearly scaffolded resulting in their more effective use.

The relationship of audio to other materials needs more consideration too. The results from the audio notes and feedback surveys indicate that student preference for one or other media can be accommodated by offering a combination of media; however the work around the capturing of conversations indicates that the value of audio can be found in the subtle qualities of learning voices (interest, empathy, meaning, and so forth) as much as in its capacity to transmit substantial amounts of information. The design and selection of media should therefore take teaching requirements into account, even in a mixed strategy.

The results from the Software Engineering project imply that the audio feedback did not have a significant impact on improving the quality of the project submissions, however it is valued as a form of feedback by the students, concurring with previous research reported by Nortcliffe and Middleton (2007). Focus group conversations and other communications with students who have studied this module have highlighted their belief that academic progression in the Software Engineering project would have been significantly inhibited without audio feedback, though the nature of the contribution may be hard to measure; earlier work has suggested that the value of audio feedback is partly found in the interpersonal qualities of the voice. This understanding informs the recommendation that the intended affect of using audio feedback should be carefully thought through and that it should be used selectively in combination with objective feedback such as short written feedback comments. Used together, these techniques can lead to formative change without incurring an unmanageable workload on the tutor. Both forms of feedback should be used to support students and actively engage them in the module. It is also recommended that students are encouraged to access the audio feedback regularly to assist them in forwarding the benefits of the feedback to the next stages of their work and in reflecting upon earlier stages.

Future work is needed to evaluate the audio methodologies with larger sample groups.

A blended approach to LTA brings many opportunities for academic innovation and student engagement. However, the extension of the learning environment, its channels and tools complicate the evaluation of the available methodologies. The teaching in Software Engineering at Sheffield Hallam University is informed by an holistic view of blended learning and is managed as an ongoing journey. Finding the right mix is difficult, but understanding the qualities and nature of the impacts of any technique is important.

The integration of the VLE with the physical space allows the educator to incrementally change their practice. This innovation should affect traditional, physically located practices as much as innovative practice is embodied within the virtual space. This paper shows, however, that the virtual space can be enhanced by the incorporation of traditional qualities too, specifically in this case, the human voice.

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