DESIGNING EDUCATIONAL SOCIAL MACHINES FOR EFFECTIVE FEEDBACK

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ABSRACT

We report on our development of an educational social machine based on the concept that feedback in communities is an effective means to support the development of communities of learning and practice. Key challenges faced by this work are how best to support educational and social interactions, how to deliver personalised tuition, and how to enable effective feedback, all in a way which is potentially scalable to thousands of users. A case study is described involving one to one and group music lessons in an on-campus, face to face, higher education context that were observed and analysed in terms of the actions carried out by the participants. The actions are described and it is shown how they can be formalised into a flowchart which represents the social interactions and activities within a lesson. Through this analysis, specific scenarios emerged where the feedback being given might not be effective, e.g. the recipient not understanding the feedback or the provision of feedback which is not specific enough. In answer to these scenarios of ineffective feedback, the requirements for a technological intervention which aims to make the feedback more effective are proposed. With this in mind, we are then able to describe a novel technological platform which has been developed as part of a large-scale European research project and which aims to support effective feedback. The platform is based around focused discussion of time based media, embedded within existing teaching activities at a research led higher education institution in the UK. We outline how it is being used in a blended learning model to support the teaching and learning of music. We reflect on the experience of developing techniques and systems for enabling communities of e-learning and describe our evaluation methodology which involves several, ongoing case studies and approximately 400 users in its current phase.

KEYWORDS

Social learning, social timeline, feedback, MOOC, music education

1. INTRODUCTION

Our research project is concerned with the development of a social machine which aims to support and enhance the experience of learning music through the optimal provision of feedback. Key challenges we face in this work are how to support educational and social interactions, how to deliver personalised music tuition, and how to enable effective feedback, all in a way which is potentially scalable to thousands of users.

In this paper, we present our method for addressing these challenges through an initial period of teaching observation and analysis followed by the development of a technological platform via a participatory design process. The methodology is summarised in figure 1. Following that, two key research outputs are presented: an analysis of one to one and group music tuition within our institution and a novel e-learning platform we

have developed in response to this analysis. The teaching analysis resulted in a list of archetypical teaching and learning activities, shown in table 1, an ontology of musical feedback, shown in figure 3 and flowcharts describing interactions within lessons as shown in figure 2. The technological platform is essentially a repository for audio and video recordings which allows the user to upload media then to share it with communities of other users who can then place comments relating to the media along a timeline. It is described as a set of system requirements in table 2 and as screenshots of its media discussion interface and social timeline in figures 4 and 5.

1.1 Background

Let us first consider what we mean by a social machine. Tim Berners Lee is credited with having coined the term social machine in 2000:

> Computers can help if we use them to create abstract social machines on the Web: processes in which the people do the creative work and the machine does the administration (Berners-Lee et al., 2000).

This quote is contextualised in the transition to web 2.0 where the process of publishing content and interacting online was democratised with technologies such as blogs, social networks and so on. In 2013, we find ourselves in the age of the social machine, where the point of interest for internet technologies is no longer the architectural underpinnings but the way in which people and machines interact within these systems. De Roure et al., are concerned with the observation of these social machines and provide some examples: Wikipedia, Ushahidi, Galaxy Zoo, reCAPTCHA and Mechanical Turk (Roure et al., 2013). Moving to the educational context, 2012 was the 'year of the MOOC' (Pappano, 2012); indeed, one of the authors of this paper ran a MOOC with an enrolled student body of 97,000. With their extreme student to staff ratios, MOOCs rely upon interactions between peers for support and assessment; this is a level of social interaction that seems beyond what has been seen previously within standard VLEs. Since they are technological systems supporting a range of social interactions, we consider them to be another example of a social machine.

Now let us consider the term 'feedback'. We define feedback in the educational context simply as a reaction to a learner's output which is somehow made visible to the learner. In higher education in general, feedback is considered very important. It is one of the key areas covered by the UK National Student Survey and historically one of the lower scoring areas in terms of student satisfaction (HEFCE, 2011). So feedback is important and is not always being done well, but how can we do it better? Juwah et al. present a list of 7 principles of good feedback in higher education, wherein good feedback a) Facilitates assessment (reflection) in learning b) Encourages teacher and peer dialogue around learning c) Helps clarify what good performance is (goals, criteria, expected standards) d) Provides opportunities to close the gap between current and desired performance, e) Delivers high quality information to students about their learning f) Encourages positive motivational beliefs and self-esteem and g) Provides information to teachers that can be used to help shape the teaching (Juwah et al., 2004). These are useful general principles but music education is a specific case where the contexts and nature of feedback are perhaps quite different. Therefore, in this paper we will present our analysis of feedback within music education with specific examples, then show how we have developed a technological system which aims to support that specialised kind of feedback.

1.2 Previous work

In this section, we will provide a brief overview of some related work in the areas of social discussion of media, online music education and peer interactions. The platform provides a media repository and timeline based discussion functionality; a similar commercial platform is Soundcloud, which allows users to maintain and share a repository of audio files and to post comments to a timeline (Bird, 2014). Considering the concept of annotations placed on a timeline, Latulipe discusses various projects using timeline based discussion systems including the 'Video Collaboratory' (Latulipe, 2013). Puig et al. developed the 'Lignes de Temps' software which provides a multitrack timeline aiming to promote polemical discussion (Puig and Monnin, 2006). Moving to the music education area, there are a range of commercial online platforms such as ArtistWorks (Marshall et al., 2014) and Berkley Online from the Berklee School of Music. Indeed Berklee

have been running musical MOOCs on the coursera platform, using SoundCloud for peer discussion (Nuernberg and Perrier, 2013). There has also been significant public research undertaken into technology for music education, such as the European funded i-maestro and VEMUS projects, both of which focused in part on the specificity of feedback (Ong et al., 2006), (Fober et al., 2007). The concept of social interactions between students within VLEs did not arrive with the xMOOC in 2012, of course; the cMOOC which came before it had perhaps a more radical, distributed pedagogy (Smith and Eng, 2013). Going further back, forums have been a standard component in VLEs for a long time and new types of VLEs emphasising social interactions have been reported in the literature. For example, Shi et al. describe their Topolor system which enables 'social personalized adaptive e-learning' (Shi et al., 2013). Finally, to contextualise our methodology, we use a grounded theory approach to analyse our lesson observations and a participatory design approach to develop the features of the platform (Charmaz, 2006), (Muller and Kuhn, 1993).

1.3 Research questions

Our research project has several high level research questions:
(1) How well does our approach increase participation in musical learning activity?
(2) How important is giving and receiving feedback online for engagement with practice?
(3) How do we correlate engagement and feedback in a community?
(4)What is the right level of social coordination and structure that students want for online-supported learning? Can we provide interfaces for non-technical people to design social coordination?
(5) How can we evidence musical competencies and musical development in students?
(6) How can automatic techniques be used to evidence feedback in music learning?

In the work presented here, we describe our 'approach' and provide evidence about the nature and importance of feedback which underpins several of the questions above. We also provide answers to how one might evidence musical competencies.

1.4 Structure of this paper

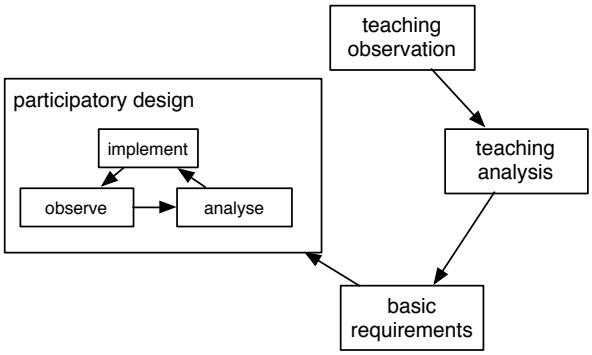
The background and motivation for the work has been presented in this section. In section 2 we will describe our methodology for building social machines combining teaching observation and participatory design. In section 3 we present the outputs of the methodology including the observed teaching and learning activities, types of feedback and a description of the features of our new platform. In section 4 we describe the ongoing evaluation of the platform with 400 users. The paper ends with a discussion and conclusion in section 5.

2. A METHODOLOGY FOR BUILDING SOCIAL MACHINES COMBINING TEACHING OBSERVATION AND PARTICIPATORY DESIGN

The development of our platform has taken place in 4 phases. In phase 1, teaching observation, we observed and recorded 23 undergraduate instrumental and vocal performance lessons at our institution. The lessons involved 9 teachers teaching guitar, voice, piano and group and 14 individual students. The lessons were in either one to one or group format and spanned the popular and classical music degrees. Recordings of the lessons were transcribed to approximately 500 pages of text and notes were taken by the researcher observing the lessons. In phase 2, analysis, a grounded theory approach was used to code the activities within the lessons in order to identify key teaching and learning activities. This approach 'fosters seeing your data in fresh ways and exploring your ideas about the data through early analytic writing' (Charmaz, 2006). The activities were then organised into higher level descriptions in the form of flowcharts describing different types of lessons. A particular emphasis was placed on the flow of feedback between participants in these lesson archetypes. In phase 3, basic requirements, we drew up some basic requirements for the platform in order for it to support the teaching effectively. This would allow us to bootstrap the basic functionality of the platform ready for the next phase. In that phase, participatory design, we used a participatory design

approach, where the input of users is sought and acted upon throughout the iterated development lifecycle (Muller and Kuhn, 1993). In a sense, the final phase includes its own observation, analysis and requirements phases, except that the observations are of users using the system (for real teaching and learning). This final phase is ongoing. Figure 1 illustrates the relationship between the 4 phases.

Figure 1: The 4 phases of platform development



3. OUTPUTS FROM THE METHOD

In this section we will present the outputs generated by the teaching analysis and participatory design process.

3.1 Enumerating teaching and learning activities

We were able to identify 9 distinct teaching and learning activities from our lesson transcripts and observation notes and these are shown in table 1 with examples of each from the transcripts.

Table 1: The 9 distinct teaching and learning activities in one to one and group music lessons

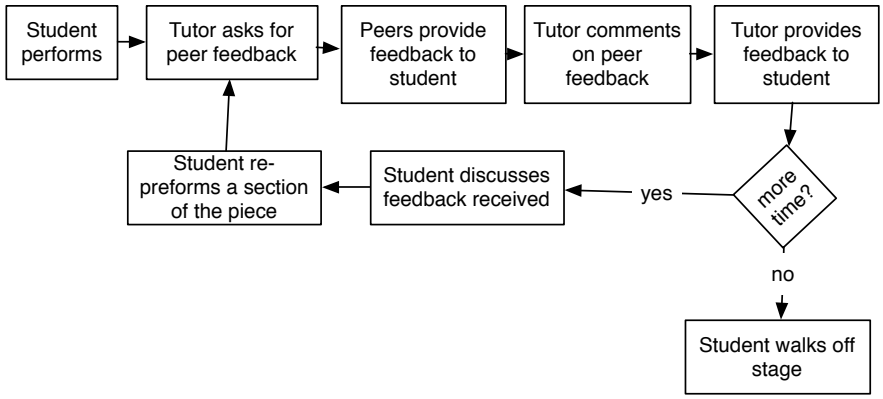
Activity	Description	Example
Transmission	**Tutors provide theoretical and practical information to students**	so whatever you do to your mouth, it's the same sound because the tongue is going right up against the soft palette, so the sound can only come out in your nose.
Performance modelling	**Tutors or students perform good and bad examples of extracts from a composition 1**	A musical activity
Identify and solve	**Identify, discuss then suggest solutions to performance problems.**	Okay, did you hear that? The music is very uneven... Let's experiment a bit. Let's do it this way. I'll play the right hand with you the first time. I am going to go for just a legato version. Then you will have a go at it hands together and I would like you try to a legato version so then you are not affected by the separation of the notes.
Practicing solutions	**Students put the solutions**	A musical activity

	from the identify and solve activity into practice in their playing	
Feeding back	**Self, peer and tutor feedback on a performance, after it has happened**	That's fine, that sounded pretty good. The very first time it sounded - your down beat sounded a little bit like `oh this is a down beat, I'm going to play loud now.' Always be careful about how you're shaping it.
Checking student understanding	**Initiated by student or tutor, student understanding is verified through dialogue**	[Tutor] From there, just flatten the 3 and you've got Dorian and add to that flatten the 6, you've got Aeolian, if you want to continue, what would you do next? Anybody know? [Student] Flatten the 2? [Tutor] Exactly right! Flatten the second, becomes? [Student] Phrygian. [Tutor] Phrygian, that's right! Which is a very nice scale, I'm fond of it.
Discussion of goals and ideas	**Discussion and negotiation of assessment or other goals and creative ideas**	[Teacher] What is romantic for you? Let's engage in this kind of discussion. What is romantic? It's important. What is romantic for you? [Students]: To express your emotions, along with that establishing a connection. [Tutor] Don't you think that being romantic also sometimes can mean trying to be a bit more individual than you normally are in the real world, to be more special?
Performing	**Students performing a prepared piece**	A musical activity
Directing	**Tutors verbally guide a student performance in real time**	[Teacher] Top string this time. Take that off so you're playing - you want that note. There's G. Put your little finger back. G7. Put your finger back. The difference where your first finger is, yes, that's suspended, that's G. You can hear it.

3.2 Teaching workflows

Through our lesson analysis, we were able to identify lesson archetypes which appeared several times in the observations. We call these archetypes ‘teaching patterns’, after Eckstein et al. (Eckstein and Bergin, 2002). A complete description of the teaching patterns is beyond the scope of this paper but a single example flowchart representing a lesson where a student performs in front of their tutor and peers can be seen in Figure 2.

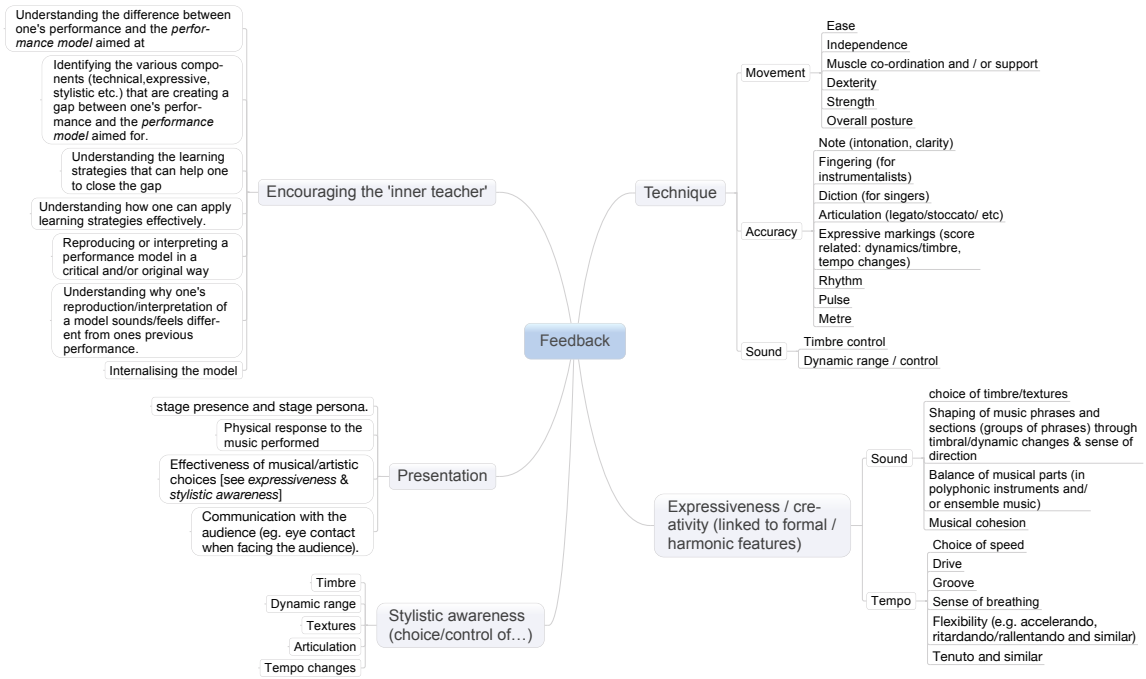
Figure 2: A flowchart describing a peer feedback lesson where a student performs in front of their peers and tutor then receives feedback



3.3 Feeding back about music

Perhaps unlike some other subjects, there is a rather discrete and finite ontology underlying the types of feedback one might receive about playing a musical instrument. As part of our analysis, and based on previous work, we have developed a detailed ontology to describe feedback on musical performance, shown in figure 3. It should be noted that we have identified two broad types of feedback: firstly, feedback connected to desirable traits in a musical performance, as shown in the majority of figure 3 and secondly, 'information for guiding tactics and strategies that process the domain specific information' after Butler and Winne (Butler and Winne, 1995). The latter might also be expressed as encouraging the learner to develop their self reflective skills, their *inner teacher*.

Figure 3: The ontology we developed which describes feedback about musical instrument playing



3.4 An understanding of problems with feedback provision motivating essential platform requirements

We now have a clear idea of the context within which feedback is given (e.g. lesson flowchart in figure 2) and the expected content of that feedback (i.e. the ontology in figure 3). However, we were able to identify several reasons why feedback might not be effective, listed below. Note that at this point, we begin to consider the basic requirements for our platform which will allow it to address these problems directly.

(1) *The underlying ontology driving the feedback is not well understood.* The platform should be able to gradually expose an ontology in a range of ways. (e.g. through suggestion of relevant terms, and the provision of automated, high level annotations)
(2) *The feedback is not remembered.* The platform should make feedback easily accessible for later reflection, not hidden away in a forum somewhere, for example.
(3) *The tutor is the sole source of trusted feedback.* The platform should embody a community of learners pedagogy, to emphasise the value of feedback from peers and tutors alike.

(4) *The feedback given to peers is not honest, e.g. 'too nice'*. By building a platform that enables more precise feedback related to a specific ontology, feedback should naturally become more honest, as the emphasis for the feedback is aimed away from the individual and towards particular aspects of a performance.
(5) *The relevance of feedback to a particular performance is not understood*. The platform should encourage the provision of feedback which is specific and well justified.
(6) *The feedback is too narrow*. Here, the feedback focuses on a limited part of the ontology, typically due to time constraints in a lesson. The platform should encourage a community discussion around a greater number of performance aspects.

3.5 Platform design

The final phase of our methodology was the iterated development of the platform. This process is ongoing, but it moved through 8 versions during the first year, where increasing numbers of users were involved at each stage. The resulting platform is essentially a repository for audio and video recordings which allows the user to upload media then to share it with communities of other users who can then leave comments along a timeline. Its key features are listed in table 2 and shown in figures 4 and 5. At the end of this first year of development, the system was in active use within 5 undergraduate modules at 2 institutions. In the following passage, the key features and motivations for their inclusion will be discussed.

Figure 4: The music circle media discussion interface. 1) The waveform display, showing a highlighted region, 2) The tagging dialogue, showing a drop down list of pre-used tags 3) The social timeline, showing sets of time linked comments created by several users 4) a discussion thread based on a single region in the recording, including an embedded youtube video

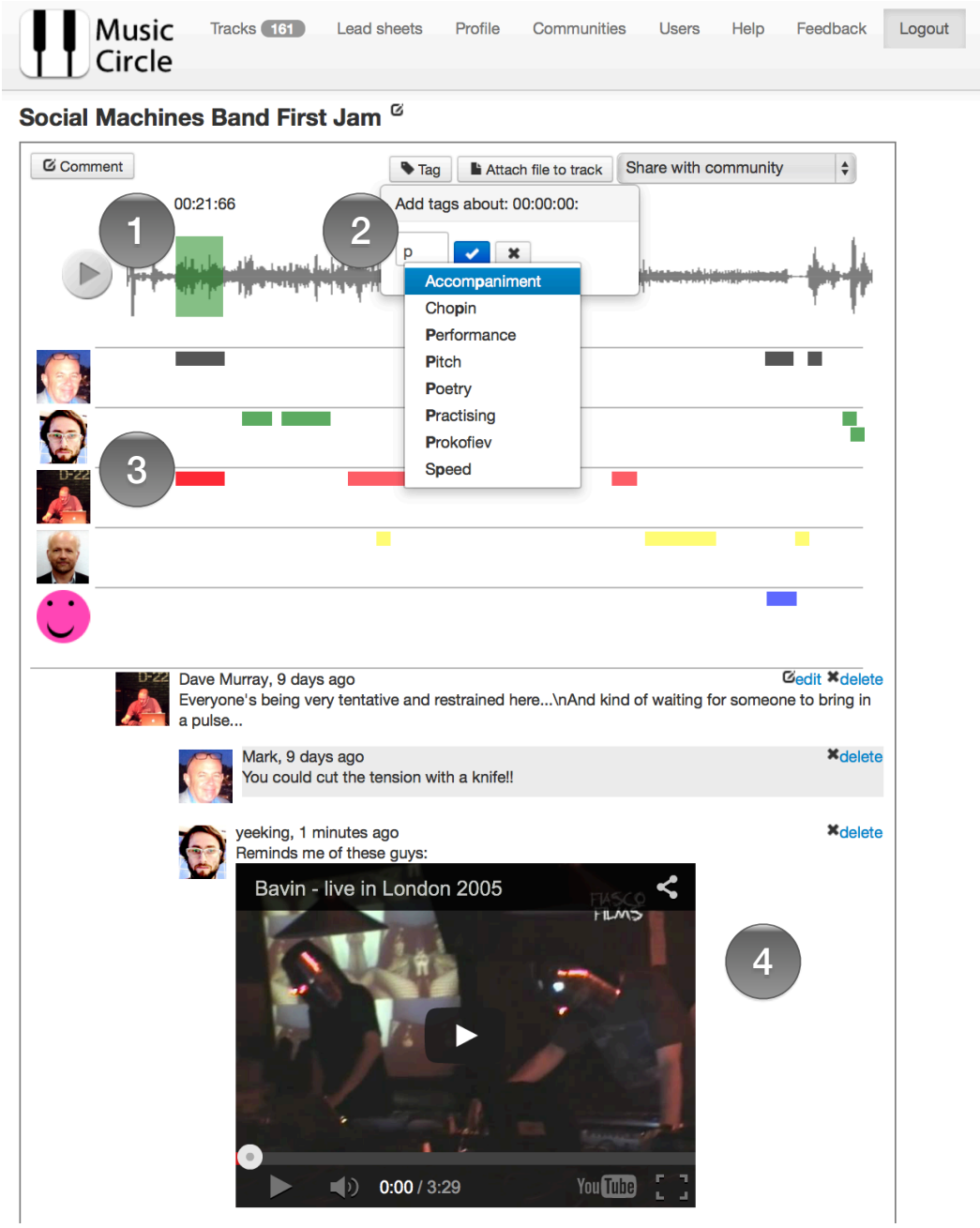


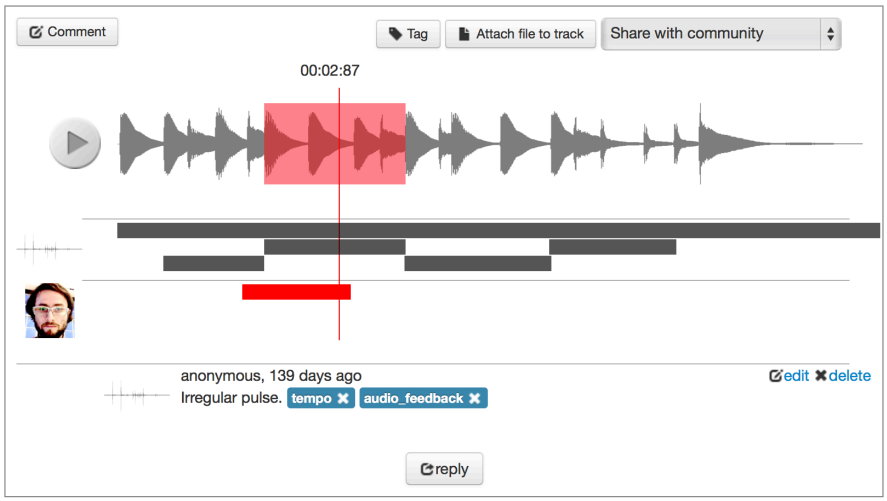
Table 2. The key features of the system compared to some pre-existing systems which we have used for teaching at our institution

Feature	MusicCircle	SoundCloud	Mahara
Easy access, personal media repository with mobile media capture client	**X**	**X**	
Simple, transparent sharing and community model	**X**		**X**
Intuitive discussion interface with content prompting	**X**	**X**	
Social timeline with region selection	**X**		
Powerful discussion system	**X**		**X**
Automatic feedback agent	**X**		

Suitability for use as a research platform (data access, privacy etc.)	**X**		**X**

Easy access, personal media repository with mobile media capture client
The aim is to remove barriers to content uploading and sharing and to make content easily accessible for later review. The platform includes simple record and upload apps for iOS and Android to make content addition as easy as possible as we identified that the often over-complex process of putting content into VLEs can be a serious barrier to uptake for students.
Simple, transparent sharing and community model
The aim is to increase user confidence in uploading and sharing media. The platform provides a very clear method of controlling who the content is shared with. Also, users can delete any comments made about their content.
Intuitive discussion interface with content prompting
This feature aims to motivate commenting activity and to encourage use and understanding of appropriate terms from the ontology.
Social timeline with region selection
Feedback is always connected to a particular range of time in the media. Also, all commenting users have individual timelines displayed below the media. This promotes awareness of the community opinions, making feedback specific to a person and a time.
Powerful discussion system
Users can reply with audio, video, text and so on. Audio and video responses within the platform can then become a subject for discussion in themselves, with their own social timeline.
Automatic feedback agent
We are developing software agents which are able to feed- back automatically about musical performances. They work by comparing different perfor- mances and making high level comments about the variations, connected to the feedback ontology. This provides a 'neutral' source of feedback and exposes the learner to the on- tology. A full description of the feedback agent is beyond the scope of this paper but it is built around machine learning and audio analysis techniques.
Suitability for use as a research platform (data access, privacy etc.)
We need to be able to ensure the data is appropriately protected and that it can be accessed for analysis throughout the project. Also, we need to be able to rapidly prototype and integrate different components to our platform for experimentation.

Figure 5: The social timeline, showing sets of annotations from two users. Each block in the timelines represents an annotation connected to a specific region in the recording. Here, the top timeline was created automatically by the feedback agent



The key features of the platform are listed in table 2, where we also compare them to the closest equivalent commercial system, SoundCloud and a well known open source e-learning tool with social features, Mahara.

4. A DESCRIPTION OF OUR ONGOING EVALUATION WITH 400 USERS ACROSS 2 INSTITUTIONS

The participatory design process aims to suggest then optimise platform features. In a sense, this represents an ongoing, evaluation and improvement cycle. However, as stated in the introduction we are interested in the evaluation of social machines and the activities they enable at a higher level than basic platform features. In this regard, we are running significant case studies with our platform with approximately 400 users spread across 2 institutions and 5 different modules. The evaluation scheme consists of qualitative and quantitative methods. In particular, we will be using interviews, survey tools and user activity metrics including social network analysis. This will allow us to address the research questions listed in section 1.3 with a variety of perspectives. We anticipate being able to analyse a data set containing hundreds of media items, thousands of comments and many thousands of interactions.

5. CONCLUSION

Work has been presented which faces the challenges of how to support educational, social interactions, how to deliver personalised music tuition, and how to enable effective feedback. A methodology for addressing the challenges has been described which takes real observational data and analyses it into formalisations of teaching and learning activities. The outputs from this methodology have been presented, including a list of key teaching and learning activities, a flowchart describing the interactions within a typical lesson, and an ontology of types of feedback. It has been shown how the outputs have been iteratively interpreted into the design for a novel e-learning platform driven by social interactions and effective feedback. The current system has been introduced and the ongoing evaluation with 400 users has been described. The immediate targets for our future work are to increase the number of learners operating within the platform, to conduct an investigation of the wider applicability of the system, for example as a means to deliver recordings of lectures and the development of our tool kit for quantitative evaluation of the system. Inspired by the examination of the importance of feedback presented here, the longer term goal is to develop a deeper understanding of the nature and importance of feedback in the learning and creative processes.

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