

Talk for collaborative learning in computer-based music production.

ABSTRACT

This article presents a case study exploring the inter-relationship between talk and learning in collaborative computer-based music production. Framed by a Sociocultural perspective on collaborative learning, research on talk and ‘thinking together’ for learning (Mercer and Littleton 2007), this study observed two undergraduate composers as they co-produced a contemporary dance film soundtrack across one academic term. The composers recorded their collaboration, providing data for a systematic moment-by-moment micro-analysis focusing on the audiovisual aspects of this project over twelve weeks. Sociocultural discourse analysis methods (Arvaja 2007; Mercer and Littleton 2007) were used to explore how social, cultural and concrete situation shaped the students’ developing common knowledge. Interaction analysis (Jordan and Henderson 1995) was used to code turn functions and display talk characteristics and patterns. This research found that collaborative computer music production is a ‘cumulative conversation’, comprised of many ‘thinking spaces’ that foster ‘post dialogic’ activity’ and ‘connection building’. In this case the students developed new ‘tools for progressive discourse’ providing them access to the remote and private ‘thinking spaces’ that are characteristic of longer term co-creating. This research argues for the development of new pedagogies that focus on understanding how talk shapes collaborative learning within music technology.

Keywords

Sociocultural theory
Collaborative creativity
Collaborative learning
Discourse analysis

Background and Introduction

Music technology education includes a diverse range of collaborative computer music practices: live electronics, and laptop ensembles, collaborative composition, and various collaborative studio based music production practices. This work is sometimes student led; delivered over several months across a variety of social and physical circumstances and assessment formats that include: peer-assessments, process journals, group vivas and assessment of the creative work itself (Alix et al. 2011). Very little is understood about what students are learning through collaborative computer-mediated creative practice. ‘Music technology’ is a ubiquitous term but an ambiguous discipline (McNichol 2012), comprised of a diverse range of sound practices, and when computer music production students are collaborating different kinds of knowledges intersect and students bring different dependencies on particular software techniques (Kirkman 2007). Choice is important for learning as it gives the student autonomy through decision-making; ‘... balance between freedoms and constraints must place independence in decision-making at the heart of the compositional experience (Burnard and Younker 2002). Thus, the freedom of students to find and work within their chosen computer-mediated spaces may be a condition for any meaningful compositional development in this context.’ (Kirkman 2011:120), but this also complicates collaborative practices.

This article addresses a significant gap in research on how the situation of student-led collaborative computer-based music production shapes learning and creativity. Existing research on music technology and learning focuses on the (inter)relationship between technology, music education, and creating, providing

insights that inform the development of technology for music learning, and music practices (Brown 2007; Brown and Dillon 2007; Crow 2006; Finney and Burnard 2010; Folkestad 1995; Folkestad, Lindström and Hargreaves 1997; Hugill 2018; King 2018; Kirkman 2007; Savage 2005). Andrew King has focused more specifically on how students collaborate when working with technology in the recording studio environment (King 2018); shifting analytic focus to the sociality of music practices in a music technology context. There is a gap in our understanding about the learning that is afforded through collaborative music practices that take place through many social and concrete situations, where composers are free to choose their own creative practice tools.

Kirkman's research on 'computer-mediated' composition (Kirkman 2011) examines multi session projects undertaken at scheduled times in classroom settings, with a focus on informing the development of new tools and interfaces for specific computer-based music composition pedagogies (Airy and Parr 2001; Dillon 2012; Kirkman 2007 and 2011; Nikolaidou 2012; McNichol 2012; Savage 2005; Seddon and O'Neill 2014). This is valuable because it shifts towards an emphasis on understanding the longer-term composition practices where learners work across many social and concrete physical settings; showing how collaborative music composition requires them to navigate various equipment and process situations, while simultaneously building a shared understanding about what it is that they are creating together. Miell and Littleton's analysis of talk across a series of extra-curricular band rehearsals, investigates the joint evaluation of musical work in progress (Miell and Littleton 2008). Their work observed the ways that conflict 'fuelled subsequent useful rounds of re-working and re-playing' (Ibid:16), and how 'opportunities for collaborative learning are fortuitous, serendipitous and improvised' (Ibid:15). Greater insight on how students talk and learn through their collaborative practice in music technology has the potential to inform the development of new pedagogies for collaborative learning and professional practice.

Guided by Vygotsky's framing of talk as a tool for higher mental development (Vygotsky 1962), a Sociocultural emphasis on talk for meaning-making, and social psychology education research observing the ways that talk is implicated in early years collaborative learning and music making (Littleton and Mercer 2013; Mercer 2000; Mercer and Littleton 2007; Mehan 1979; Rojas-Drummond, Albarr and Littleton 2008, Vass 2004), the research presented in this article explores how learning develops through collaborative music composition, with particular emphasis on understanding the role of talk and other sociocultural tools.

Research questions

This research asked how collaborative computer-based music composition is mediated by social and cultural contexts over time. To investigate inter-relationships between practice and context this work asked the following more specific questions:

- How do undergraduates (re)negotiate common knowledge, shared meaning and a collective understanding of their interdisciplinary collaborative creating over time?
- How is talk in particular implicated in the genesis and negotiation of ideas and creative work over time?

Methodology

The methodology is guided by Sociocultural studies on collaborative learning and creativity that prioritise a temporal analysis of the co-construction of work of how

learners talk and think together (Mercer and Littleton 2007; Green 2007), how social and cultural contexts are used as resources for meaning-making and learning (Claxton and Wells 2002; Vass 2004; Rojas-Drummond et al. 2006; Rojas-Drummond et al. 2008), the nature of distributed creativity of collaborative emergence in Jazz (Kenny 2014) and in theatre (Sawyer and DeZutter), the negotiation of music making through talk by band musicians (Miell and Littleton 2008), and research exploring mediation of music technology over time and various learning environments (Kirkman 2011; Savage 2004).

This research methodology adopted an 'ethnographic perspective' (Mehan 1979; Hammersley and Atkinson 1995) to investigate one term-long collaboration through the naturally occurring phases of activity in their natural social and concrete contexts. Analysis focused on participants' discourse to understand the relationship between their situation and how this informed the emergence of their actions over time (Gee and Green 1998) adopting a Sociocultural perspective to investigate how the undergraduate collaborative music composition process is shaped through a situated and emergent mediating inter-relationship with their situation. Sociocultural research on collaborative creativity focuses on analysing events as they are occurring moment-by-moment (Arvaja 2009; Vass 2004; Sawyer and DeZutter 2009): 'To study something historically means to study it in the process of change; that is the dialectical method's basic demand. To encompass in research the process of a given thing's development in all its phases and changes – from birth to death – fundamentally means to discover its nature, its essence, for 'it is only in movement that a body shows what it is.' (Vygotsky 1978: 64-65).

This ecological approach focuses on the emergence of activities through their evolving inter-relationships within social, cultural and concrete situation over time, facilitating a focus on the emergence of actions (Amabile 1996; Craft 2000; Lahti et al. 2004; John-Steiner and Mahn 2002; John-Steiner 2000; Littleton et al. 2008; John-Steiner and Moran 2004; Sawyer 2012). The Sociocultural lens affords analysis of '...the 'tools' that people use, and that shape the ways they think and act...' (Claxton and Wells, 2002, p4). These tools are not simply technologies, or physical objects. This study looked closely at the tools the students themselves made relevant themselves, and in particular their use of language: a psychological tool (Vygotsky). In this way it examined the mediating inter-relationship between the 'long-term improvised narrative' (Sawyer and DeZutter, 2009) of the students' co-creating and their 'ecology' (Grossen, 2008) of practice over time.

Participant Selection

This study was undertaken at the satellite campus of a UK university where final year undergraduate students could choose an optional multi-disciplinary module on collaboration and performance. The module was available to students from courses in music technology, theatre, dance and English Language. Students were invited to pitch project proposals, form teams and present a portfolio of work for assessment. Assessment included a process diary, group presentation/viva, and a 10-minute performance of original work. Students attended four lectures about the module, and collaboration theory, followed by regular meetings with an academic tutor. They had access to two Apple Mac computer labs, three theatre studios, various audio recording studios, the student café and their private facilities, plus a wide range of audio and video recording equipment.

All 44 students on the module were invited participate in this study. Participant information and consent documents were disseminated, to provide

information on what participation would involve, that it was voluntary, and also that it would not positively or detrimentally influence their formal academic work¹. Students were also informed that their identity would remain anonymous², that they could withdraw from the study at any time without consequence to their studies.

Of the groups consenting three were initially selected because they included two or more composers approaching this project with an intention to work collaboratively. They were also willing to document their practice. Semi-structured interviews were then conducted to seek contextual information about: the composers' individual music practices, their use of technology, and their social, and cultural background.

One group documented their full collaboration, and was therefore selected for this study. This group included two music technology students, a dancer and a film maker. The composers co-developed one soundtrack for an original 10 minute contemporary dance film.

The composers

These composers were enrolled on a Creative Music Technology BA (Hons) degree. Here they are referred to as Liam and John.

Liam's background was in popular music arranging, studio recording and performance (drums). In his interview, he described his composition process as computer-based: building complex textures in Logic 8³ and Max MSP. His preferred location for writing music was on his laptop while travelling on trains. His influences included Square Pusher and Aphex Twin. He enjoyed 'hectic' music, Liam described his creative process: 'I start with some kind of percussion or the bass ... then I'll get an idea, and then manipulate it with effects, that's what I use for my variation ... and then from there I just start layering things together, and if it works it works, and if it doesn't I don't bother with it really.'.

The other composer John also had a background in popular music. He produced covers of songs, using existing recordings and virtual instruments. He used Cubase VST 5, writing music in his own room on his laptop, with a MIDI keyboard. He described two creating processes: '...[I] start from some sort of synth based thing, maybe chords would be one place to start. Start mucking around with sort of something melodic. Maybe if I like it, record it in, loop it. Then maybe I'll go through, I'm quite impatient when I'm composing sometimes I'll just leave that maybe eight bars and then move straight on and then put the next idea down just because I've got the next idea in my head and then do it, and then I know what'll sound good on that. Then do that, and then sort of work on a B section, which means that stuff never really gets finished. The other approach is a lot slower, a lot more laborious. Starting off say a kick drum, and then making some sort of sound out of that kick drum then moving on then thinking what sort of sound would complement

¹ The research followed the British Education Research Association guidelines for research on human interaction within education (2004). It was approved by the Open University's Human Participants and Material Ethic's Committee.

² Pseudonyms are used in this article

³ Typically students use Logic, Cubase or a similar digital audio workstation (DAW); it is not uncommon for computer-based practitioners to have different DAW preference, and be resistant to learning a new one.

that. Once I have an eight bar, 16 bar loop of something I'd worked on maybe rhythmically or just sound wise, I would get an idea of how to, what that can then maybe lead in to. What could be laid on top and how it could become musical.' John is describing a process of software mediated improvisation, following particular patterns (to start with chords, melody and loop while adding new ideas). Both composers described solitary, technology mediated and semi-improvised practice.

Data collected

From October to January (inclusively) these composers documented their collaborative process as it was occurring naturally and spontaneously through all of their social and physical settings. They made audio and video recordings using their own smart phones and digital cameras, producing 24 hours audio recordings from 28 meetings in the following locations:

- Two Apple Mac computer labs (set up for music and video production);
- Three theatre/dance studios (resourced with video cameras and sound recording equipment);
- One sound recording studio;
- And recreational environments (at home, a campus café and unspecified spaces where composers worked in parallel on laptops with headphones).

Multimodal data, including eight hours of video, photographs of lists, diagrams of graphic scores, their film and sound was also collected. The data was catalogued by: date, location, participants present, and meetings purpose (i.e. to present work to a tutor, record audio, or to discuss ideas).

Data analysis

This research was investigating how collaborative computer-based music composition is mediated by social and cultural contexts over time, so analysis needed to observe collaborative emergence, at a micro, moment-by-moment analytic level across all of their collaborative meetings.

The data was imported into (Caqdas) Nvivo for coding to show the focus of their discussion. This revealed rapid shifts in focus between practical logistics, academic requirements, individual roles and the development of creative ideas. This research needed to identify and follow one specific strand of creative focus to understand how it was developed across all of their social and concrete situations of making. This thematic analysis (Braun and Clarke 2006) revealed a set of topics and they are referred to here as 'collaborative, conceptual creative themes' the most recurrent were:

- Conversations exploring how to use space (in film, contemporary dance, and surround sound);
- Conversations about the aesthetic (genre, narrative and cultural influences);
- Conversations about the audiovisual relationship between the soundtrack, dance and film.

The developmental work on this audiovisual relationship was selected for analysis because it was explored jointly across the full length of the collaboration, across all of the social and concrete settings. To ensure that this theme was captured systematically for analysis, next, analytic episodes were established in data that showed the students:

- Co-composing the soundtrack;

- Discussing the audiovisual content or process;
- Or sharing ideas that linked with the soundtrack.

This process of selecting themes and only episodes focused on one specific theme, reduced 24 hours of recordings down to one hour, 56 minutes and 20 seconds of data which spanned the entire length of the project, in all co-creating situations. These episodes were catalogued, transcribed for analysis.

Data analysis

Two analytic methods were combined, for analysis of meaning-making, and insight on how the students were accomplishing a shared understanding of their work in relationship with their social, cultural, conceptual and technological setting.

Firstly, Maarit Arvada's 'socioculturally framed discursive approach' (Arvaja, 2007 and 2008) was used to identify their use of 'contextual resources':

- Their concrete and physical context (rooms and equipment including technology present, remembered or anticipated);
- Their sociocultural context (cultural events, key practitioners, concepts and practices);
- And their immediate group context (the module, past meetings, other module activities, and meetings with tutors).

This discourse analysis method examined how students used their immediate perceptual context, local and socio-cultural 'contexts' as resource meaning-making. Each episode was annotated to show where students' conversation made reference to these contexts, as seen below in Figure 1.

Figure 1: Transcription example: contexts resourced⁴

CONTEXTS					
	Speaker	Dialogue	Local: immediate group context as a resource for meaning- making	Concrete and physical: as a resource for meaning- making	Socio-cultural: knowledge as a resource for meaning-making
1	Liam	How much of, er sorry, er, how much of space do you use when you're doing dance, or how much you thinking if you've got like a room is it very static or does it move round quite a bit?	Directing question at Dancer	Use of space	Establishing identity of <i>Dancer</i> with more expert knowledge in this area
2	Dancer	It depends.			
3	Liam	Yeh			
4	Dancer	Like I'm choreographing a solo now			Reference to another project [reinforcing identity as a specialist in dance]
5	Liam	Yeh			
6	Dancer	That's like literally like all on one spot, I'm not gonna move of	Anticipated future contribution	Use of space	
7	Liam	Yeh			
8	Dancer	() square,		Use of space	
9	Liam	Yeh			
10	Dancer	but you can use any space really.		Use of space	Knowledge of practice [reinforcing identity as a specialist in dance]
11	Liam	Yeh			
12	Dancer	I don't know, it's really, it's a really general question			Value judgment of the question [reinforcing identity as a specialist in dance]

⁴ The names of the dancer and film maker have been removed from this transcript

13	Liam	Yeh, its just coz I'm thinking of, about the surround sound aspect, and it'd be nice to move the sounds around as you move around and have it synchronised with that aspect as well as well as just synchronised with the sounds, so just whether that's feasible and worth doing or just stick with the stereo	Offers possible creative avenue for the group to consider	Sound in space	Shares expert knowledge as the composer [reinforcing identity as a specialist in music technology]
14	Film maker	For erm... sta this quite intense like study, I wondered you know like, you know in surround sound?	Reference to Liam's suggestion of surround sound		
15	Liam	Yeh			
16	Film maker	When we show the DVD, it's kinda like this, but	Reference to local knowledge: DVD for performance	DVD	
17	Liam	<i>(inaudible contribution)</i>			
18	Film maker	if we have 4 projectors in a square and have like a tiny gap and it'd be like the audience come in and just sit like on the floor or whatever		Describes space and technology.	

This approach showed the students using their context in various ways; revealing past experiences (shared and private), anticipated practices, and tools (concepts and technologies). In this transcription excerpt the dancer and composer are establishing their roles (as domain specialists) within the group, drawing attention to how remote (remembered and anticipated) ideas and facilities contribute to the development of their ideas moment-by-moment. It revealed how they utilise contexts when negotiating practice, for example, drawing on remembered and anticipated uses of space that leads into technical possibilities and anticipated use of technology and audience experience. This approach helped display the unpredictable and rapid movement between practical logistics, roles and creative trajectories. This analytic approach also revealed their 'collaborative emergence' (Sawyer and DeZutter, 2009) in their practice.

'-The activity has an unpredictable outcome, rather than a scripted, known endpoint;

- There is moment-to-moment contingency: each person's action depends on the on just before;

- The interactional effect of any given action can be changed by the subsequent actions of other participants; and

- The process is collaborative, with each participant contributing equally.'

(Sawyer and DeZutter, 2009, p82)

A characterisation of collaborative that comes from Sawyer and DeZutter's use of interaction analysis (Jordan and Henderson 1995, Sawyer and DeZutter 2009),

a method of turn coding drew from cognitive science to tag each contribution with a turn function. Interested in understanding the composers' collaborative emergence, in this study individual turns were coded in all episodes, until no new codes could be identified. This resulted in a set of codes which were used for annotation and analysis of the transcripts:

Figure 2: Codes

Introducing creative ideas

- S Suggestion
- CS Creative Suggestion
- PS Process Suggestion

Showing agreement by directly accepting, supporting or developing the idea

- Su Support for suggestion
- AC Accepted Creative suggestion
- DC Developed Creative suggestion
- AP Accepted Process suggestion
- DP Developed Process suggestion

Challenging, rejecting or engaging with a challenge

- Co Concern expressed
- CR Creative suggestion Rejected
- CC Creative suggestion Challenged
- PR Process suggestion Rejected
- PC Process suggestion Challenged
- CCA/R Challenge to Creative suggestion Accepted/Rejected
- PCA/R Challenge to Process suggestion Accepted/Rejected

Questioning, challenging, explaining, checking and confirming in dialogue

- QI Asking Questions for further Information
- E Explaining meaning (a suggestion, or a question)
- U Showing Understanding
- Ch Checking the another person's understanding
- Su Supporting
- Conf Confirming
- A Agreeing
- RptS/O Repeating Self/Other

The function of every turn was then annotated in the transcribed episodes and figure 3 presents an example of coded turns in situ, with further annotations to show how this informed an understanding about talk.

Figure 3: Transcription example: interaction analysis

Turn	Speaker	Dialogue	Function
1	Liam	How much of, oh sorry, er, how much of space do you use when you're doing dance, or how much you thinking if you've got like a room is it very static or does it move round quite a bit?	QI E <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-left: 10px;">QUESTION WITH QUALIFYING EXPLANATION</div>

2	Dancer	It depends.	E
3	Liam	Yeh	
4	Dancer	Like I'm choreographing a solo now	E
5	Liam	Yeh	
6	Dancer	That's like literally like all on one spot, I'm not gonna move of	E
7	Liam	Yeh	
8	Dancer	a square,	E
9	Liam	Yeh	
10	Dancer	but you can use any space really.	E
11	Liam	Yeh	
12	Dancer	I don't know, it's really, it's a really general question	E
13	Liam	Yeh, its just coz I'm thinking of, about the surround sound aspect, and it'd be nice to move the sounds around as you move around and have it synchronised with that aspect as well as well as just synchronised with the sounds, so just whether that's feasible and worth doing or just stick with the stereo	E QI SC <small>MOVING TO CUMULATIVE TALK: CHARACTERISED BY A CUMULATIVE AND UNCHALLENGED BUILDING OF IDEAS.</small>
14	Film maker	For erm... sta this quite intense like study, I wondered you know like, you know in surround sound?	DC AC
15	Liam	Yeh	
16	Film maker	When we show the DVD, it's kinda like this, but	DC AC
17	Liam	We were discussing this weren't we	
18	Film maker	if we have 4 projectors in a square and have like a tiny gap and it'd be like the audience come in and just sit like on the floor or whatever	DC SC
19	Liam	Yeh	
20	Film maker	Erm, facing any projection, just like, show the same DVD same thing	E
21	John	Ah ok.	AC
22	Film maker	Have like speakers there, there, there, there	E DC
23	John	That sounds perfect	Su

This coding reveals talk patterns. Here the students open with a question which is immediately augmented with contextual explanation (in turn 1). It prompts a phase of thinking aloud from the dancer then the film maker. We see the students engaged in a kind of improvised narrative (Sawyer and DeZutter, 2009). Each new proposal for a development in the narrative is the creative inspiration of one person, but that proposal does not become a part of the play until the other members of the group respond to it, and potentially redefine it retrospectively. (Ibid, p83).

In this sense then the transcripts reveal much more than a simple exchange of ideas. Coding helps display the quality of talk. For example paying close attention to children engaged in talk and their joint construction of meaning, Neil Mercer and Karen Littleton observed that children do not simply interact, but that they actually ‘interthink’ (Mercer and Littleton, 2007; 2014). A term "coined to convey the meaning that people cannot only act together (interact), they can think together (interthink)" (Warwick et al., 2016, p. 557).

Mercer and Littleton’s Thinking Together project present a link between language, interthinking and three characterisations of talk: ‘Disputational talk’, ‘Exploratory talk’ and ‘Cumulative talk’ (Mercer, 2000; Littleton, et. al 2005; Mercer and Littleton, 2007):

‘Disputational talk’, seen where there is disagreement and individualized decision making, and characterized by ‘short exchanges consisting of assertions and challenges or counter assertions’ (Mercer, 2004 p146). It is not considered to be collaboratively or developmentally valuable.

‘Exploratory talk’, displaying a critical and constructive engagement with ideas which ‘may be counter-challenged, but challenges are justified and alternative hypotheses are offered. Partners all actively participate and opinions are sought and considered before decisions are jointly made.’ (Mercer, 2004, p146). When engaged in ‘exploratory talk’ ‘knowledge is made more publicly accountable and reasoning more visible in the talk.’ (ibid).

‘Cumulative talk’, describing an accumulative building of positive and uncritical contributions developing a local common knowledge. Interactions display agreement and uncritical acceptance of creative suggestions. ‘Cumulative talk’ fosters peer confidence (John-Steiner and Mahn, 2002) and a feeling of shared endeavor (Mercer and Littleton, 2007).

By using these talk type characterisations it becomes possible to analyse the quality of talk in relationship with collaborative emergence of practice and ideas. For example Figure 2 displays cumulative talk, ‘interthinking’ (Mercer and Littleton 2007); uncritical agreement with a feeling of shared endeavour. This facilitates a sharing of practices and ways of using space, as well as ideas for how space may be used in the final piece.

This combination of coding and discourse analysis shows how contexts are used for meaning-making, alongside analysis of talk functions in a way that reveals patterns of talk through the development of the audiovisual theme. A systematic micro-analysis which shows how their collaborative computer based music composition was mediated by social and cultural contexts, including technology but especially language through the full collaborative project; showing how ‘joint, co-ordinated intellectual activity’ (Mercer, 2000, p16) unfolds in relation to the students social and cognitive processes, as well as their collective development of knowledge.

Findings

This article offers two contributions to our understanding of how talk fosters learning in collaborative computer-based music production:

- 1) Collaborative computer music production fosters a ‘cumulative conversation’ comprised of multiple ‘thinking spaces’, fostering ‘connection building’ and ‘post dialogic activity’.
- 2) Student can create strategies for accessing the remote and private ‘thinking spaces’ through the creation and use of new tools for meaning making.

By looking at how process was mediated by social and cultural contexts in this way, this work offers a Sociocultural perspective on how learning can be afforded through term long collaborative computer music production practices. The main contribution is evidence that music production practices like this can foster intermental meaning-making activities, defined here as a ‘cumulative conversation’: an improvised narrative (Sawyer and DeZutter, 2009) where students are developing common knowledge of practice over time, across multiple ‘thinking spaces’ (Perret Claremont, 2003), where practice is continued by episode of ‘interthinking’ (Mercer and Littleton, 2007), and private episode of ‘post dialogic’ activity (Howe, 2010). In this case, learners were also engaged in ‘connection building’ (Gee and Green, 1998) and created ‘tools for progressive discourse’ (Bereiter, 1994; Wells, 2000).

Interthinking, connection building, silent witnessing and post-dialogic activity.

During this twelve-week project the two composers developed their worked across many joint and private episodes. Developing a sonic pallet and structure for the 10-minute soundtrack. Their collaboration exhibited ‘interthinking’ (Mercer and Littleton, 2007). This is demonstrated in Figures 3 and 4 where the composers were considering the sonic pallet for this project.

Figure 4: sonic interthinking

Name	Discourse	Interaction functions
John	Erm. Sure so what sounds are we gonna use?	CUMULATIVE TALK: CHARACTERISED BY CH, CS, QI, E, DC, SU, AND A.
Liam	I’m thinking, shuffling.	
John	No I mean, what source sounds?	Questioning for information
Liam	Ye I’m. Erm, shuffling could be. Something which is high pitched and sounds like a wasp or something, or can make sound like a wasp.	Repeating, creative suggestion, Explaining
John	Ok	
Liam	You know. To go with the frantic movement of the feet. I don’t mean like a wasp but that kind of	Explaining
John	Maybe a high pitched noise with erm	Developing creative idea
Liam	Metallic sound	Developing creative idea
John	Yeh (sort of like a) metallic sound like it was erm, sort of like a thud underneath, like erm, if you heard a club from er,... ten minutes away	Developing creative idea
Liam	Yeh	Support

John	boom boom boom boom	Explaining
Liam	Something in the distance?	Checking Developing creative idea
John	Yeh a distant reverb and bass in it	Explaining
Liam	Yeh, er	
John	Gradually getting louder and then when it comes to the drawing bit and then it cuts down, just... <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-left: 100px;">STARTS USING THE COMPUTER</div>	Developing creative idea
Liam	Yeh	
John	Yeh Erm	
Liam	Do we think... when does that thing cut in the then new scene where the with her marking? Like roughly?	Checking seeing information
John	Roughly ten seconds. So we we're doing a ten second gesture for the...	Confirming
Liam	We're not we're doing an eight second gesture.... nine second gesture if we have a minute of	Checking Suggesting
John	A minute... good stuff. So what sort of sound will we need then?	Checking
Liam	Erm, I'm just having a think of what we recorded	Checking Creative, and process suggestion
John	Well there's erm. We've got the singing bowl? <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-left: 100px;">Playing sounds from the computer</div>	Creative suggestion
Liam	Yes	Agree
John	Do you have any idea where that is?	Checking
Liam	No, no clue	
John	Well I'm a bit confused as to... cuz you've got 'B format'	Checking
Tape	[playing sound: male voice speaking]	

This episode shows interthinking focused on establishing the composers' sonic pallet. Discourse contains checks refinements of meaning, and a reliance on common points of reference. Sound is described causally (caused by a wasp or metallic object), reductively (high pitched metallic) and even performatively (boom boom) (which might possibly reflect approaches that might have been discussed on their course with reference to Michel Chion). The composers are using dialogue to think aloud, to explore and to build on each other's ideas, their interaction is a kind of improvised music making through talk (Harrison and Pound, 1996; Sawyer, 2003; Seddon, 2005). They could not anticipate the trajectory of ideas or practice, and interthinking has opened a window through which they can see meaning-making and how that informs the development of this work. There is a cumulative quality to their talk, which helped the composers to share knowledge about sound, and move through a discussion of the sonic pallet and related practical and aesthetic decisions.

Throughout this project the composers' creative practice was socially constructed through language in this way. They were also engaged in 'connection building': a range of 'constructing processes within and across time and events' (Gee and Green, 1998, p121) connection building can be identified by asking:

'What sorts of connections (intercontextual ties) are made to previous or future interactions, to other people, ideas, things, institutions, and discourses outside the current interaction?

What sorts of connections (intercontextual ties) are made to previous processes and practices (cultural patterns) and proposed, recognized, and acknowledged as socially significant outside the current interaction?

Which processes, practice, and discourses do members raw on from previous events/situations to guide the actions in the current situation (e.g., text construction)?'

(Gee and Green, 1998, p141)

In Figure 4 the students refer to the film, past sound recordings and wider cultural knowledge to move the project forward. Music technology is full of opportunities for connection building, through media files, cultural references, links to shared learning experiences, professional and extra curricular practices.

As the composers started to work on a computer their interaction changed: they stopped describing sounds and begin linking past events and recordings to anticipated activities. The quality of their talk also shifted from 'cumulative' to 'disputational'.

Figure 5: disrupted interthinking

Name	Discourse	Interaction functions
John	I reckon the rem, take a bit of the article, the article scrabbling one, we can make a descent sound with that.	Creative suggestion Explaining
Liam	I'm going with the (not audible)	Suggestion
John	Ok Well I think that will work well together	Agreement Confirming
	[short time passes]	
John	Yeh?	Checking
Liam	Yeh	Agreement
John	Come on Liam we need to be vocal. I don't need 'yeeeh'.	Concern Explaining
Liam	Yeh I'm just doing my, I thought we were working separately.	Explaining
John	I know I know... but I will I want confidence, with you.	Concern Explaining
Liam	I know but right now I'm just	Explaining
John	Yeh but it doesn't matter	Concern Explaining
Liam	feeling a bit scratty so I'm just yeh	Concern Explaining

John	We're fine, but don't make me feel bad. Don't make me feel like I'm sitting here not helping	Concern Explaining
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Liam is searching for sounds on a computer. John can see what Liam is doing, however he presses for a verbal response ‘Come on Liam we need to be vocal I don't need “yeeeh”’. They are no longer interthinking and he has detected a shift in Liam's focus. A disputational quality of talk is emerging and John explicitly says what he is seeking from Liam: ‘Don't make me feel like I'm sitting here not helping’, ‘I want confidence, with you’. There has been a transition from remembering and imagining, from ‘connection building’ to a more solitary computer-based practice, and Liam seems to be engaged in a computer orientated ‘flow’ (Csikszentmihaly, 1992): shift from creating, to managing their interaction. Though student might not have analytic tools to identify and articulate such a shift, they might detect shifts that affect interthinking.

Through connection building the students shared information from different social groups. Figure 6 presents a transcript showing the students exploring structure.

Figure 6: silent witnessing and post-dialogic reflection

Name	Discourse	Interaction functions
Liam	How much free reign do we have, on this? [meaning, the structure of the project]	Question
John	What do you mean?	Checking
Liam	With [the dancer and film maker], do you think we can do this n will be happy with it do you think do we need to consult them, or or do you...	Question Explaining
John	...well considering that Kate already talked bout Cunningham	Explaining
Liam	Yeh	
John	she knew who, I didn't even know who Cunningham is	Explaining
Liam	yeh	
John	So she already knew about the Cage Cunningham relationship	Explaining
Liam	Yeh	
John	I presume she'll know a bit about chance music, or be open to the fact that that's what we're doing	Explaining Suggesting

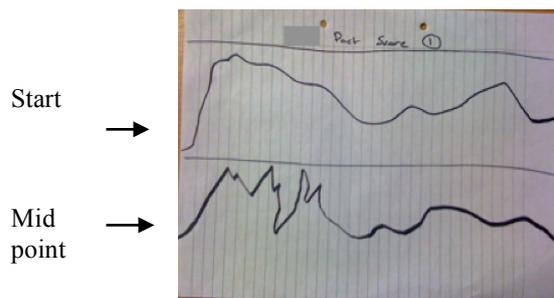
At this point (half way into the academic term), the film was not yet complete, and the composers were looking for a way to produce one soundtrack jointly. In Figure 6 they reach two decisions: firstly an idea to adopt an aleatoric approach (working independently); then they decide to sketch imagined structures based on what they have seen so far. In T5 John recounts an earlier conversation he had witnessed where Kate talked about the aleatoric approach adopted by Cage and Cunningham. As that conversation constituted part of the data video recorded for this research, analysis showed that he was not engaged in the discussion, but quietly

printing documents in the same room. Kate had talk about the collaborative practice of Cunningham and Cage, so he suggests that the dancers know about Cage and Cunningham, offering this aleatoric approach as a solution for their practice. These episodes revealed the complex interactional accomplishment of collaborative computer music production (Dobson and Littleton, 2015), but specifically how their ‘cumulative conversation’ draws on all various social settings, and also private ‘thinking spaces’ (Perret-Clermont, 2003) over time. Students do witness interthinking and thinking aloud episodes, and these insights can feed back into the emerging group knowledge across different meetings.

Resourcefulness: Tools for progressive discourse and accessing remote thinking spaces.

Throughout this collaboration the students imagined practices and hypothetical conversations in order to solve the problems that they could not have anticipated (Dobson and Littleton, 2015). They were particularly resourceful in their meaning-making practices. In this project the composers had decided to work independently on their soundtracks, but still bring ideas back together for review. They needed to agree on a structure to enable this. To agree this structure they sketched graphic scores from their memory of the film and past meetings.

Image 1: Graphic score sketch



Each sketch had a start, middle, and an end. Figure 7 presents a transcript of the moment immediately following their creation of these scores; an episode of meaning-making which explored what this afforded them.

Figure 7: Creating and exploring a new tool for progressive discourse

Name	Discourse	Interaction functions
Liam	So yeh.	
John	Yeh	
Liam	So we’ve got this.	Explaining
John	Yeh. It doesn’t really mean anything though does it.	Concern
Liam	Structure. No.	Suggestion and rejection Agreement
John	I mean either that I mean that the structure could be the structure or it might could not be it doesn’t really matter does it.	Explaining

Liam	I think because we're just, we're when we draw the structure out we're still just sort of groping around a little bit and we don't know what we're going for I think we should do quite a few rough ones.	Explaining Concern Process Suggestion
John	Oh yeh definitely	Agree
Liam	and then pick one that looks the most interesting and combine the two.	Suggestion
John	Yeh I mean literally, I literally drew that. I drew the black line first. Taking into consideration velocity and sort of impacts of sound, that was just an up and down thing.	Agree Explaining
Liam	Yeh	
John	But I didn't really, sort of, make it that dramatic.	Explaining
Liam	Mm.	
John	It was very just, a made up thing.	Explaining Concern

The composers struggled to establish what these sketches could represent and how they could be useful 'it doesn't really mean anything does it', 'that was just an up and down thing' and 'it was just, a made up thing'. The composers seem to be engaged in a kind of knowledge cartography (Okada et. al, 2008), recalling mapping and clarifying their intellectual commitments through discourse. The sketches could be described as 'self-referenced' forms of notation (Banberger and Dissessa, 2003), displaying relative proportional measurement, such as height and time. Notated representations like this offer opportunities for different interpretations to be developed, particularly when engaged 'self explaining'. The composers explored this inherent ambiguity leading John to suggest some possible interpretations and offer further insight into his thought process when he was creating one: '...taking into consideration velocity and sort of impacts of sound,'. According to Healey and Thiebaut (2007) '...some of the benefits of sketching derive specifically from their relative ambiguity and vagueness.' (2007, p1079) and observing children working with graphic scores in music, Bamberger and Dissessa suggests that graphic representations of music, and the operationalization of graphic scores are not merely demonstrations of what is on the page, they are psychological processes that are creative and mediated by perceptual influence (Banberger and Dissessa, 2003). 'It is through joint engagement that ideas are argued over, contested, borrowed and shared as our understanding is advanced' (Rojas-Drummond, Albarrán and Littleton, 2008, p177).

The composers had created a problem that led to exploratory phase of talk. These sketches might even be viewed as tools for 'progressive discourse' (Bereiter, 1994); a kind of dialogue 'that is focused on the object of the activity and aimed at making an answer to a question or a solution to a problem to which the activity has given rise.' (Wells, 2000, p75). They decided to create another four sketches each, opening a discussion of specific memories about the film and earlier meetings. John begins pointing to particular parts of the sketches, sharing memories along with his reasoning:

'That first scene was the flashy bit and that was reasonably dramatic.
And then I, I you made this score around the fact that I already knew

that was going to be the first scene. That was really really heavy, but it wasn't, heavy, it didn't have a lot of weight to it, it was just, loud... not much actually sounds going on, so it may be one sound doing a lot.'...

John is still making sense of this process. He describes his memory of a scene, how Liam's composition was informed by shared knowledge of what is happening in that scene, then refines his description of the scene describing it as 'heavy'. When peers are engaged in thinking together they mutually develop personal and collaborative confidence through 'self-explaining' (Chi and Bassok, 1989). John is attempting to solve the problem of interpreting his sketch through 'self-explaining'.

... 'here, which I saw as the just pacing it as this score was half way through the mud scene which is the only scene I've seen, apart from that one, which is really really intense, like that's got a lot of power to it, and Kate showed us a lot of times... so I put that five minutes because I thought that makes sense in terms of structure. It comes half way through the piece, she's starting off with something loud... for minute of quiet after that sort of thing, and then bam there, and again. But I don't know maybe it could go there.'

He points at the middle point on the sketched timeline, remembering 'the mud scene', explaining that he has placed it at five minutes because it has 'a lot of power to it'.

The creation of these sketches led the composers to explore their ideas through another a kind 'exploratory talk' offered by Douglas Barnes: 'Exploratory talk is hesitant and incomplete because it enables the speaker to try out ideas, to hear how they sound, to see what other make of them, to arrange information and ideas into different patters.' (Barnes, 2008, p5). The composers often explored their ideas this way; while considering how they might use space, and technology. Often this form of presentational exploratory talk was preceded by episodes of 'cumulative talk' (Mercer). Cumulative talk appeared to support their confidence to explore how ideas sound, and see what peers think of them.

In long-term collaborative projects like this students are engaged in meaning-making that is resourced by episodes of 'interthinking'. They are connection building, self-explaining, and potentially creating tools for progressive discourse to navigate their creation of work across multiple 'thinking spaces' (Perret-Clermont, 2003). This is interesting because developmental psychologist Christine Howe found that when resolving differences children benefit from having time to reflect independently, and advocates that 'post-dialogic' activity has a helpful contribution to co-creating. This study of undergraduate composers also observed 'silent witnessing' and that students are engaged in such 'post dialogic' activity.

Conclusions

Collaborative creativity has a social dynamic which has received very little attention in education research focused on higher music technology education. Research on collaborative learning, musical creativity and music education show the complex interrelationships at play, push for greater investigation into the sociality of contemporary (and increasingly technology mediated and collaborative) music making (Burnard, 2018; King, 2018; Lapidaki, DeGroot and Stagkos, 2018). Burnard

asks how ‘communal and collaborative, empathetic and intercultural creativities in music interact and feed each other?’ (Burnard, 2018, p18-19), following an earlier call for ‘multiple forms of music pedagogy, where creativity (like inspiration) comes from outside in *and* inside out as a process inseparable from technology, playing into and recruiting different forms of pedagogy.’ (Burnard, 2007). By asking what kinds of learning are afforded by collaborative computer-based music production, this study offers a number of implications for learning, assessment and development of professional skills.

This research shows that collaborative computer music production promotes learning and resourcefulness through talk and the findings underscore a need for further pedagogical development in the area of musical socialization in computer-based music practice specifically. It advocates that such work may promote an understanding about ways of talking and strategies for navigating the multiple thinking spaces of collaborative practice. The Sociocultural discourse, moment-by-moment analysis of a term-long collaborative computer music process introduced the concept of a ‘cumulative conversation’: aligning research on talk types and ‘collaborative emergence’. This work also draws attention to the cognitive demand on students who are collaborating on creative work across multiple ‘thinking spaces;’ (Perret-Clermont, 2003): private practice, ‘interthinking’, ‘silent witnessing’, and ‘post-dialogic’ reflection. In particular, this research observed the students developing tools for progressive discourse, sketches that open up remote activities through self-explaining and various kinds of exploratory talk.

This article invites us to imagine how students might harness their capacity for collaboration by developing an understanding about their talk, and ways to foster common knowledge, as Lapidaki et. al. suggest ‘... we are required – whatever our perceived expertise might be – to be critically reflective about our practice and about how different tools and/or techniques might serve and facilitate our intent, our philosophy, and our moral values’ (Lapidaki et. al 2018 p123). Children have been taught to recognize talk types, and understand how to use them while collaborating (Mercer, 2000 and 2004; Mercer and Littleton, 2007; Littleton and Mercer, 2013; Wegerif, 2007), so undergraduates may also become responsible for developing self-awareness about the process choices that shape their contexts as they are happening. It is plausible that undergraduate composers are already sensitive to shifts in talk and collaborative engagement, so there may be scope for tertiary level pedagogy to be developed in this area. Existing assessment mechanisms include presentations, journals, peer assessment, and the creative outputs, however with training on talk, connection building techniques, and techniques for eliciting ‘interthinking’ a new pedagogical development might introduce a new assessment framework that aids collaborative learning more intentionally to foster higher mental development through collaboration. Learning outcomes might prioritise self-reflection on strategies for developing progressive discourse, and productive talk; co-development that draws on multiple thinking spaces in a way that acknowledges the influence of independent, as well as co-dependent practices within a cumulative conversation.

Though this qualitatively deep investigation offers useful implications for music technology education, it is based on a small sample of participants, so further research might explore the progression of talk focused pedagogies for music, perhaps drawing on sociocultural discourse analysis methods, and in particular how this has been applied in research of primary children thinking together (Mercer and Littleton, 2007).

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