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**Sampling composition: how Year 12 music technology
students use sample-based processes
to compose electroacoustic music**

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Abstract

Composing with music technology is often perceived and documented to introduce the additional challenge of technological mediation to the composition process, especially when the technology is viewed as a tool which enables students to expand their creative musicianship as hyphenated musicians. In this article, I present a case study which outlines the particular processes and features behind four Year 12 music technology students' electroacoustic compositions (a genre which only exists due to the creative utilisation of music technology), and consider the effectiveness of a pedagogical approach which I term a 'semantically informed pedagogy'. Findings highlight the importance of catering for the students' different musical roles and placing the listening experience at the heart of the composition process, in order for the human skill and determination behind the work of art to remain fundamental when threatened by the potentially mediating effects of music technology.

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Introduction

Using music technology as a compositional tool and platform is a current issue fraught with controversies, due to the correlation between students' compositional agency and technological mediation becoming increasingly questionable (A.P. Bell, 2015, p.47; Louth, 2013, p.137). A-Level music technology students have no choice but to use technology to compose: producing a technology-focussed composition is an essential requirement of the course. Therefore, such students encounter continual challenges relating to the mediating effects of technology on both a musical and technological level. How to use music technology to compose, how to use technology to explore and expand upon compositional ideas, and how teachers support this process are all fundamental elements of a composition project which students realising a successful composition will encounter. Therefore, understanding how students use music technology itself is essential in order for teachers to be able to support and guide them through all stages of a technology-based composition.

Entering the music technology classroom with diverse and particular experiences, many students use music technology to complement and enhance areas of their broader musicianship, and therefore part of this study considers how the students' uses of technology reflects such broader musicianship. This is akin to students entering the English literature classroom: some students may possess the literary skills but lack some of the technological skills required to use a word processor proficiently, and others may be adequately skilled at word processing but unfamiliar with correctly using grammar, syntax, and creative writing techniques. All students, however, regardless of their specific interests and backgrounds, study the subject to broaden their capabilities within the discipline in its most comprehensive sense.

As ‘hyphenated’ (diverse) musicians (Tobias, 2012, p.329), both teachers and students require a pedagogy which capitalises on their varied and unique backgrounds and experiences. This study considers the compositional and technological processes employed by Y12 music technology students during an electroacoustic composition project at an all-boys state school in England, and analyses how teachers plan to support students during the project, throughout both a series of taught audio transformation techniques, and during the students’ own personal musical and technological explorations. In the first section, I discuss and evaluate the current literature surrounding technology-focussed composition by setting out to address the question of whether students are typically viewed as composing intentionally and deliberately, or whether their compositional decisions are viewed as being guided – and to some extent dictated - by the technology itself. I then outline the methodology used in this study and present my findings, discussing emerging implications for future practice, which are centred around notions of a ‘semantically informed’ pedagogy – a potential example of an effective pedagogy which emerged during this research project.

Literature review: technically composing, or composing technically?

Using technology to compose music forms an essential part of any music technology course, and, for many students, is a fundamental activity which defines their very musicianship. In this section, I consider various authors’ works to outline some of the issues that students and teachers encounter when composing, teaching, and learning with music technology, reconceptualise a definition of composition which encompasses all musical genres, explore how students and teachers must be wary of the mediating effects of the technology itself, and conclude by evaluating different authors’ suggested pedagogical strategies.

Technology and composition

‘Anyone can compose’ with music technology

Music technology as an instrumental platform which students use to produce musical products is argued by some authors to make composition so accessible that it “allows students at all levels of musical experience and knowledge to compose” (Wise, 2016, p.285). Bell (2015) describes this misconception as the facile fallacy: the notion that music can be composed immediately and

effortlessly with music technology (p.53). However, whilst increased accessibility to compositional experiences theoretically leads to a more inclusive creative practice (Burnard 2007, 2011, as cited in Macedo, 2013, p.208), one seemingly overlooked issue is students' proficiency in using the hardware and software itself. Clearly music technology teachers seek to equip students with the appropriate skills required to utilise the technology available to them, however it appears that students' backgrounds and experiences are often overlooked. Savage (2007) explores how 'digital natives' – "native speakers of the digital language of computers, video games and the Internet" (p.65) – are better positioned than 'digital immigrants' to embrace new music technologies (p.75), and by extension computer-based compositional practices. However, Nielsen (2013) finds that students with 'musical backgrounds', as opposed to students with 'technology backgrounds', are still better positioned as composers (p.58), due to their increased understanding of common practice musical conventions, such as functional tonality and phrase rhythm (p.57), which refer to notions of music as being based around chord progressions in order to facilitate musical 'movement' and logical development. Perhaps this is also due to teachers wrongly assuming that the 'digitally native' generation are able to intuitively use technology to aid or produce their musical compositions, even if they do not possess a 'technology background' as described by Nielsen. It is clear, therefore, that traditional notions of composition must be reconsidered to allow for the modern practices of 'digital natives' to be fairly recognised, taught, and assessed in a music technology focused, computer-based compositional context.

(Re)Defining "composition"

The term "composition" is generally accepted as referring to "the activity or process of creating music, and the product of such activity" (Blum, 2001). Louth (2013) contends that "composing" is a 'loose' term in the context of technology-focussed composition, since spontaneous sounds or ideas are captured and manipulated/transformed through wildly different processes in comparison to notated musical ideas (p.143). Adopting a broad definition of music as being "humanly organised sound" (Nettl, 2001), I suggest that a definition of composition that encompasses computer-based as well as traditional compositional methods could be 'the human activity or process of creating music by manipulating, transforming, and/or organising sounds, and the product of such an activity', since, as Macedo (2013) discusses, a broad definition of music (and composition) allows music technology to be viewed as an extension of the resources available to a creative musician (p.213). Such a view removes arguments regarding the validity of non-technology-focussed

composition as compared with computer-based composition, allowing a broad definition of music to encompass both approaches.

As Savage (2007) explains, technology facilitates new approaches to composition (p.69), although we must challenge conservatism to ensure that successes in computer-based composition are not judged by whether or not traditional musical approaches are enforced (p.71). This view is also held by composers of electroacoustic music, a genre of music designed to “explore new sound shapes and timbres both by transforming recorded sources and by synthesizing new sounds, and to break the confines of fixed pitch and metrically based approaches to rhythm” (Emmerson & Smalley, 2001). Whilst creating original music which breaches traditional musical boundaries in theory allows for a free and open compositional experience, the “centrality of the listening experience as the foundation of all music and musical knowledge” (Macedo, 2013, p.210) remains essential for all musical compositions, in order for composers to understand and critique their own work. Macedo (2013, pp.125-126) goes on to list six listening modes that are essential to music technologists/composers:

open listening – the listener chooses which aspect of the aural experience to focus on;

syntactical listening – the listener attempts to identify specific musical elements and compositional processes;

semantic listening – the listener derives meanings from any text associated with the composition;

ontological listening – the listener is aware of the broader world views of the composer;

reduced listening – the listener considers the sound itself as separate from its source; and

technical ear training – the listener focuses on aspects of technical sound production, such as equalisation.

Each of these six modes of listening consider the experience of sound from the listener’s perspective (Hill, 2018, p.51), and composers must be aware of the various ways in which their works might be interpreted due to the application of these listening modes. Interestingly, Smalley – an electroacoustic composer and theorist - (as cited in Moore, Moore, Pearse & Stansbie, 2013) advocates against technical ear training, since he is wary of the focus being placed on the technological processes behind the music, rather than the music itself (p.326). However, in the context of a music technology course, technical ear training is a vital tool for any technology-focussed composer to possess. Interestingly, Tobias (2012) suggests that the manner in which we interact with music is changing, due to music technology contributing to the merging of the

“traditional roles of listener, performer, and composer” (p.331). Music technologists, therefore, are forced to adopt many different roles during the course of a composition project, and can be referred to as what Tobias (2012) calls hyphenated musicians: “thinking and acting as songwriters, performers, sound engineers, recordists, mix engineers and producers in ways that are recursive and often overlapping” (p.329). Hyphenated musicians, therefore, must think about music in diverse ways, depending on the specifics of the activity they are engaged with, and music technology educators must therefore be careful not to compartmentalise the practices of hyphenated musicians, in order for music composition to “no longer be considered a separate activity in the music making process” (Nielsen, 2013, p.61).

The mediating effects of technology

Although the human musical mind is fundamentally essential to inaugurate an act of composition, the way that technology itself influences the creative process (Louth, 2013, p.146) – and eventually the end product – appears to be particularly relevant to music technology educators.

Many modern genres, including electroacoustic music, rely on music technology to exist; without music technology, the compositional processes utilised within such genres would be impossible to realise, and perhaps even to conceptualise. However, users of music technology are exposed to technological designs that simultaneously “allow and restrict freedom” within the compositional process (Louth, 2013, p.149). Bell (2015) also questions the mediating effects of technology, and examines which user-initiated actions are either presumed – the basic conditions that the user must meet to be able to use the technology; privileged – the default settings and pre-sets in a program; provided – when the software directs the user towards an action that is privileged; protected – the capabilities of a program that are hidden from the user; or prevented – actions that the Digital Audio Workstation (DAW) does not permit (pp.55-61). Each type of design feature relates to the notion of affordance – the interactions of people with objects (A.P. Bell, 2015, p.47). Bell’s notions of affordance relate directly to Reynolds’ (2005) consideration of the computer as scaffold, since they direct teachers and students to consider what the electronic environment does, and what it enables (p.242).

Whilst Bell (2015) is concerned with students and educators being wary of the possibility that music technology restricts creative compositional choices, other authors advocate for music technology as an extension of the tools available to musicians (Macedo, 2013, p.217), and as an

expansion of the “palette of sounds” available for students to explore or discover (Hill, 2018, p.54) – thus promoting different ways of thinking about and communicating music (Reynolds, 2005, p.247). If the focus of an act of technology-focussed composition is concerned with composers’ engagement with the “microphenomena of musical sound itself” (Savage, 2007, p.73), then perhaps any mediating effects must simply be accepted, since without the technology itself such engagement would be impossible. Therefore, sound and sample-based composition (composing with short recorded ‘chunks’ of sound) appears particularly vulnerable to technological mediation. Louth (2013) adopts a middle-ground position on this issue, since he initially claims that “technology itself will always mediate the creative process and affect the outcome” (p.146), and later goes on to state that music technology software (including DAWs) should be viewed as “extensions of human agency” (p.147). As music technology educators, we must, therefore, concern ourselves with raising “awareness of the way in which technological design simultaneously allows and restricts freedom” (Louth, 2013, p.149), whatever our views regarding the controversial mediating effects of such technologies may be.

Teaching technology-based composition

Pedagogy

References to specific music technology pedagogies appear to be lacking in the current literature, with many authors positioning the use of technology as an additional component of a traditional music education (Savage, 2007, p.66). However, Beckstead (2007, as cited in Wise, 2016) classifies pedagogies in music education which involve technology as either *amplicative* – enhancing existing ways of musicking; or *transformative* – presenting new ways of thinking about and interacting with music (p.286). Such classification of the effects of various pedagogies can be related to Savage’s (2007) notion that technology is either used by teachers to reinforce traditional educational frameworks (an amplicative pedagogy), or it is used to transform the very nature of subject disciplines (a transformative pedagogy) (p.66). Clearly both types of pedagogy are required within a music technology course that does not seek to juxtapose the two components of ‘music’ and ‘technology’. Interestingly, some teachers adopt *procedural* pedagogies in the context of technology-focussed composition, whereby they focus on teaching students how to use the required software and hardware (Wise, 2016, p.285), which perhaps further juxtaposes both components of music technology courses by separating technological and musical skills. Alternatively, adopting

such an approach may prove to scaffold students' compositions. However, it also appears to be dangerous to juxtapose these types of pedagogy themselves, since all three approaches may be required at different points within courses, or even within individual lessons. Perhaps viewing transformative pedagogies as evolved amplicative practices scaffolded by procedural pedagogies represents a balanced view of both Beckstead's and Wise's classifications (I have devised Figure 1 below to visually represent this concept), although it must be noted that what constitutes a new way of thinking about and interacting with music will not always remain current or revolutionary. Therefore, pedagogies must evolve *with* and utilise new technologies.

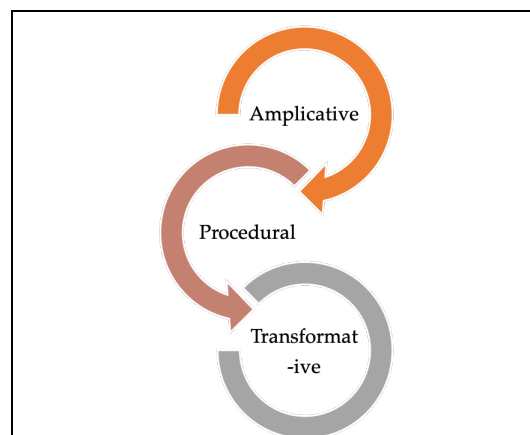


Figure 1: Amplicative and transformative pedagogies scaffolded by procedural pedagogies

'Sound Teachers'

One way of music educators evolving pedagogies with new technologies is to reposition ourselves as sound teachers (Hill, 2018), whereby we embrace all sounds and consider them in relation to their specific sonic qualities (p.51), which allows us to free ourselves “from the narrow concepts that have defined school music and music teaching, opening us to new ways of thinking about our roles in classrooms and our goals for students' learning in music” (p.50). Sound teachers are therefore helping students to listen “more attentively to the sounds of their world”, in an attempt to bring the worlds of art and reality closer together (Hill, 2018, p.60).

“...technology grants access to music and sound worlds that are exciting and creatively gratifying to work in; where once it would be the lucky few that got the chance to hear a symphony orchestra perform their work, now this situation can be simulated relatively easily and convincingly”

(Kardos, 2012, p.150)

The same notion can be applied to sound and sample-based musics: once a minority of musicians had access to the technology required to explore the sonic qualities of sound in such depth, and now everyone carries such technology with them in the form of a mobile phone (A.P. Bell, 2015, p.46). Once distant sound worlds are, arguably, now universally accessible.

In order to position ourselves as sound teachers, we should "seek not to impose one correct idea, but rather to accompany and guide students as they explore and refine their own individual relationships with understanding, creating, manipulating, and performing sound" (Hill, 2018, p.58), and therefore avoiding a rules-based approach to composition is essential. This extends to not dismissing any humanly organised sound as not classifying as music, or an act of composition. However, when using procedural pedagogies to scaffold students' usage of technology, employing a series of teacher-centred, invariable tasks is common practice (Wise, 2016, p.285), which undermines Hill's notion of avoiding rules-based approaches to composition. Procedural pedagogies are clearly useful for cultivating students' technical - both technological and musical - skills, and therefore perhaps both Hill's and Wise's positions on the approach counterbalance each other and support the use of procedural pedagogies as a temporary scaffolding stage in sample and sound-based compositional processes.

From hearing to realising

Both Macedo (2013, p.216) – an electroacoustic composer and lecturer - and Kardos (2012, pp.146-148) – a senior lecturer in music, technology, and education - present five-stage learning strategies which attempt to develop students' activities from listening to music to producing a fully realised composition (as presented in Table 1).

Stage	Macedo (2013, p.216)	Kardos (2012, pp.146-148)
1	The experience of sound, consisting of listening to processed and non- processed sounds or sounds created with different methods of synthesis.	Critical listening to the piece/similar pieces.
2	Students' responses to the sounds.	Diatonic harmony in 4-part arrangement.
3	Analysis of the students' experiences.	Understanding the use of polyrhythm.
4	Introduction of theoretical concepts, such as the principles and methods of processing and synthesis used, their technical characteristics and how to work with them.	Performance nuance and the timbre/ambience of the performance environment and mix (sound world emulation using virtual instruments, velocities, reverbs and compression).
5	Integration of new concepts into general knowledge, with the discussion of the musical contexts in which they have been or may be used, and listening to musical works in which they have been used. Practical use of the processes taught in compositional studies or compositions.	Creating a score (using a DAW).

Table 1: Macedo and Kardos' five-stage learning strategies

Crucially, both authors' strategies begin with students listening to, as opposed to visually analysing, pieces of music which are sonically related to the students' compositional intentions, interests, or needs. Not only does stage one reinforce the need for a 'sound before symbol' approach to composition (Hill, 2018, p.57), but it also highlights how the different modes of listening can affect the compositional process from the very beginning: if teachers do not direct students towards different listening modes at different points in the process, then students may be unaware of what they are listening to or for: a problem which is further compounded by the potential internal conflicts of hyphenated musicians. Interestingly, Kardos' learning strategy – based on a case study conducted with undergraduate students - appears to represent an amplicative pedagogy, since traditional methods and concepts are used and explored at each stage, whilst Macedo's strategy – based on phenomenological literature - appears to be transformative, scaffolded by procedural pedagogies at stage four. Although Kardos (2012, p.146) advocates for a student-centred approach by learning through discovery, her five-stage learning strategy suggests that students are directed towards following a series of teacher-directed steps which relate to traditional notions of musical composition. Macedo, on the other hand, clearly places emphasis on students' engagement with the music itself at each stage of the process. Both strategies present composition as a process which takes place through the completion of a number of stages, broken down into "manageable tasks" (Kardos, 2012, p.145), and illustrate two somewhat contrasting procedural pedagogies. If music technologists are taught using procedural pedagogies, how then can students truly learn to compose through discovery and capitalise on their own experiences?

Learning through discovery: personal explorations

Learning through discovery requires traditional classroom roles to be reconsidered or adjusted. Interestingly, the roles of both teachers and students within the classroom become broader and multifaceted, in order to facilitate the varied, interconnected roles of hyphenated musicians (Tobias, 2012, p.343). Teachers, therefore, must position themselves as facilitators (Savage, 2007, p.70; Wise, Greenwood, and Davis, 2011, p.129), in order to support students in the various ways they engage with music as hyphenated musicians. If students view themselves as possessing many different musical roles (Hill, 2018, p.55), then so too must teachers. If teachers can become – or already are - hyphenated musicians themselves, then perhaps facilitating students to learn through discovery becomes a matter of encouraging students to trial different roles at every stage of the compositional process, in order for their various musical attitudes to be fairly deliberated and expressed. Technology-focussed composition provides a hybrid space – an environment that allows different musical roles to thrive (Tobias, 2012; Hill, 2018, p.55) – due to the many different approaches to the task that students and teachers can take, which enables independent learning to flourish (Savage, 2007, p.73).

Some authors (A.P. Bell, 2015, p.46; Louth, 2013, p.149) make analogies which compare users of music technology to users of other technologies, and claim that adroitness with music technology does not make its users more musically proficient. Perhaps these authors confuse the purpose of music technology, which is not, in and of itself, to cultivate students' musicianship, but rather it is used to provide students with a platform – a hybrid space – which they can use to explore music from a multiplicity of roles and perspectives. Just as some features of a word processor may provide structures which support aspiring writers to create literary works, so too may music technology for musicians and music technologists.

Teaching technology-focussed composition to digitally native, hyphenated musicians must, therefore, be carefully planned to capitalise upon: the perceived accessibility of music technology, a broad definition of “composition” which focuses on the sonic qualities of sounds and does not dismiss any humanly organised sound as not constituting music, the possible mediating effects of technology itself, transformative alongside amplicative pedagogies, and the role of independent learning in the compositional process. In light of the aforementioned context, this study investigates

how Year 12 music technology students use sample-based processes to compose electroacoustic music. The study was guided by the following research questions:

RQ1: How do teachers plan to support students creating a sample-based composition?

RQ2: How do students use music technology within the composition process?

RQ3: To what extent are the techniques used by students developed beyond teacher explanations into personal explorations?

Methodology and methods

This paper draws on data gathered during a mixed-methods study examining four Year 12 music technology students' use of music technology during a composition project lasting four weeks and comprising of six lessons. Such data is considered to exist within an interpretivist paradigm, and from a social constructivist perspective. During this study, a combination of research methods were used, culminating in the thematic coding of student questionnaires, review presentations, and students' written work. Themes were analysed and validated against the students' practical work. From this thematic coding and analysis, a combination of quantitative and qualitative data was extracted, which was then used to inform the case study presented in the following section.

As Bassey (1999) discusses, a case study is “the examination of an instance in action” realised due to “the imagination of the case and the invention of the study” (p.24). Case studies, therefore, rely on cause and effect, and allow individuals to be studied in relation to their particular case and/or environment. This paper presents a case study which is descriptive in nature, and presents explanations of phenomena within the specific context of a Y12 music technology class (Yin, 1993, p.5). Therefore, this study is intrinsic, and is an example of research into a “particular situation for its own sake” (Stake, 1995, p.3): it is simply concerned with the particularities of the ‘imagined case’ and the ‘invented study’. Issues are discovered and studied in order to gain a full understanding of the case at hand (Adelman, Jenkins, & Kemmis, 1976, p.49). Whilst case studies provide data which is rich in detail, based on the complexity of ‘social truths’, and which can form the basis of future action on the issue (ibid., pp.59–60), “the unique problem in case study is in justifying to others why the researcher can be a knowledgeable observer-participant who [can] tell what s/he sees”(Kemmis, 1980, as cited in Bassey, 1999, p.25). From this stems the issue of generalisation, with various authors questioning the validity of the study of singular events (J. Bell,

2010, p.9). Two solutions to the issue of incorrect generalisation are clear: either researchers and readers accept that the focus and purpose of case studies is ‘particularisation’ rather than generalisation, and/or generalisations are left to be made by the reader – a process which Stake (1995) terms naturalistic generalisation (p.7). It then becomes crucial that the researcher does not make unsupported propositional generalisations (Stake, 1995, p.8). At the heart of case study research is the “study of a singularity which is of interest to the researcher” (J. Bell, 2010, p.75), and therefore the inability to confidently generalise is simply an inherent consequence of studying peculiar situations.

This case study focuses on one single-sex, mixed-ability class of four Year 12 A-Level music technology students at an ‘all-boys’ state school in England: Harry, Aaron, Melvin, and Noah (all names have been pseudonymised to protect the identities of those involved with the research). Music technology lessons were taught in an open-plan computer lab, with computers positioned around the perimeter of the room. Each computer ran a Windows 10 operating system, and had a MIDI keyboard controller, an audio interface, and stereo headphones attached. An interactive whiteboard at the front of the classroom was available for the teacher to use. The Digital Audio Workstation (DAW) used throughout the project was Reason 10.

The four students were presented with a composition task which was designed to enable them to both fulfil the requirements of Component 2 of the Edexcel music technology specification, and also to address the research questions. Students were presented with a composition brief, a video file, and five unprocessed samples, and were required to compose, in an electroacoustic style, for three ‘scenes’ from the video which were identified by the teacher. Students composed each scene chronologically, but were able to retrospectively alter their work. Scenes one and two were utilised to scaffold students’ compositional and technological transformations, by presenting them with a series of taught audio transformation techniques: time-stretching, vari-speed/transposing, delay, filtering, splicing, reversal, looping, layering, stuttering, and synthesis parameters. These taught techniques were required by the Edexcel A-Level course specification. Students were free at all times to use as many or as few of the taught techniques as they deemed necessary for each scene, and were encouraged to utilise further transformation techniques if they so desired. Scene three was presented as a ‘free composition’ task, in which students did not receive any further teacher input. Before the composition phase of the project began, students were asked to plan their response to

each scene, and were exposed to electroacoustic music as a genre through a series of structured listening activities.

Questionnaires were used to gain an understanding of the students' own beliefs surrounding their hyphenated musicianship, and students were prompted to select as many different roles as they felt best described them as musicians, and provide a short description of their experiences with the identified roles. Students also kept logbook commentary sheets which detailed the transformation techniques (both taught and non-taught) used in each scene, and students were prompted to provide an explanation as to why each technique had been specifically utilised. Online PowerPoint presentations were used at the end of the project to gauge overall understanding and to provide students with an opportunity to review and evaluate the project, and their own compositions, in line with the research questions. Students also submitted their project (Reason) files for each scene. The questionnaires, logbook commentary sheets, and review presentations were thematically coded in line with the literature outlined in the previous section, the Edexcel music technology Component 2 composition specification, and the audio transformation techniques, to identify any emerging themes. At every stage during the coding process, the students' project files were cross-consulted, to ensure that any process or technique mentioned in the other data was indeed used, and to ensure that any techniques present in the project files, but not alluded to in the other data, were not excluded from the overall analyses. This provided a method of triangulation, since the data is considered from the various perspectives of the students, and considered in line with literature and the teacher's planning and research notes.

This research was conducted in line with the current guidelines on educational research ethics issued by the British Educational Research Association (BERA, 2018), and at all stages respect for democracy, truth, and persons was considered and protected (Bassey, 1999, p.74). The study was deemed to be ethical by the Faculty of Education, University of Cambridge, due to the successful submission of an 'ethics checklist'.

Findings and discussion

How do teachers plan to support students creating a sample-based composition?

Two intertwined pedagogies (*semantically informed* and *procedural*) were utilised throughout this project, both of which illustrate the centrality of students' listening experiences; teachers guided students to employ and utilise different listening modes (Macedo, 2013, pp.215–216), in both the planning and realisation stages of the compositional process. During Lesson 1, the process of employing these different listening modes was modelled to the students in a series of structured listening activities, in order to ensure that they understood and recognised the different modes of listening before utilising them within their own compositional processes.

Within their own compositional processes students most commonly utilised the *semantic* mode of listening, whereby they inferred meanings about their own music from any associated text, although the definition of “text” should be expanded to include the video element of this project. During their review presentations, the students continuously implied that their musical compositional decisions were informed by the semantic listening mode:

“...I spliced up Sample Two again...to represent...the little spikes that come up from the ground” (Harry)

“I used this to add a drone that lasts the whole scene and [to represent] machine sounds” (Aaron)

“...put it together in a short burst to create a warning sound effect due to the red flashing lights used in the piece...” (Melvin)

“I...used a lot of [a]ttack due to the quick movement of the machines in scene One” (Noah)

The students' desires to relate their compositional decisions to the semantic listening mode highlights that a listening informed pedagogy was employed: technical (both musical and technological) processes – and eventually proficiencies - were taught by allowing students to associate inferential meanings with each decision made. For example, Melvin desired to musically represent the “flashing lights” in the video, yet to do this he required the technological skills to arrange the samples into a “short burst”. Identifying that students responded most effectively to this mode of listening informed subsequent lesson planning and one-to-one support for students, since technical skills were taught in relation to the perceived impact that their realisation would have on

the externalised action occurring in the video. Utilising this semantically informed pedagogy allowed for differentiation to be achieved through providing the relevant technological support in order to enable the students to realise their technological and musical intentions. Perhaps this is an example of a procedural pedagogy (Wise, 2016, p.285), but one which is concerned with transforming the nature of students' technological and musical understandings through the continual externalisation of compositional purpose. This approach is clearly not the "rules bound" compositional pedagogy advocated against by Hill (2018, p.56), and perhaps begins to partly exemplify a *transformative* pedagogy as described by Way and Webb (2007, as cited in Wise et al., 2011), in the sense that the approach demonstrated the "use of multimodal information" and a "move from teacher-centred to student-centred learning activities" (p.120). The teacher, therefore, accepted and built upon the students' personal inferences when relating them to any technical processes, and found opportunities to support and empower students as they progressed through the different stages of their creative perceptions and musical/technological outcomes. This approach adhered to Macedo's (2013) five-step project (p.216), which is designed to equip the students with the appropriate skills to become music technologists: all perceptions and experiences are unique to each student, and therefore the teaching capitalised on such perceptions and experiences (see Figure 2 below, for example, where students are instructed to relate their technical work to their own, personal interpretations of the onscreen action). There is, therefore, a clear correlation between the design of my own exemplar task outlined in Figure 2 and the students' responses explored above in relation to the semantic listening mode.

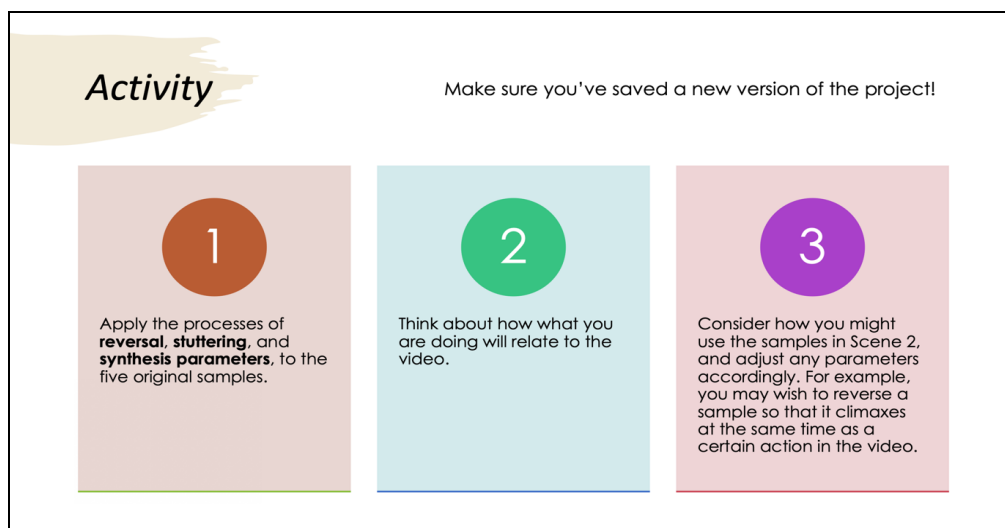


Figure 2: A student-centred task (from lesson four of the project) designed to enable the teacher to capitalise on students' perceptions and experiences

Whilst capitalising on the semantic listening mode demonstrates a unique and personalised pedagogy, using Macedo's (2013, pp.215–216) *syntactical* and *technological* listening modes was also crucial to employing such a pedagogical approach. *Syntactical* listening refers to listening to/for specific musical elements and compositional processes, and identifying structural elements (Macedo, 2013, p.215). As the project progressed, some of the students began to independently label the sections of their compositions, as evidenced in the logbook entries and research notes:

09/03/2020	Intro – title (Aaron) “Students began labelling sections themselves: e.g. “during the introduction I did....” (Lesson 3, Research Notes)
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It appears, therefore, that syntactical listening can be a powerful pedagogical tool for teachers to use, so that generic musical conventions – such as large-scale structure -can be first felt and realised by students in their own compositional practice, with specific terminology applied either retrospectively, or midway through the process. This demonstrates a fundamental advantage of using music technology to compose: musical intent, albeit semantically informed, can be realised without any syntactical barriers being formed. It is the teacher's role to guide any retrospective syntactical listening, although it is clear that some students will apply such analyses independently. It is interesting to note that the two students who began to segment their own compositions into large-scale sectional structures were the students who, as evidenced by the questionnaire responses and review presentations, most strongly self-identified as *performers*, rather than as composers or listeners. This is illustrated in Figure 3, where Harry and Aaron clearly possess the largest proportions of *performer* identities (represented by the blue regions of the stacked bar charts) in comparison with Melvin and Noah. Perhaps these students have internalised large-scale structures through their performance practices, and thus express a desire to discuss their work using the same conventional musical terminology. At all points, therefore, I allowed students to choose how they described and discussed the musical components of their technology-focussed compositions: a context in which technological listening is likely to dominate.

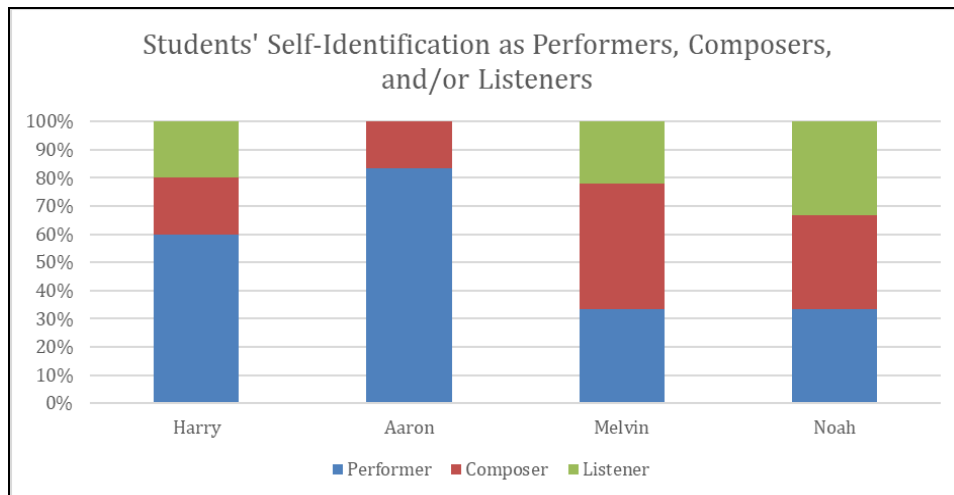


Figure 3: A stacked bar chart detailing students' self-identification as performers, composers, and/or listeners

Technological listening (Macedo, 2013, p.216) relates directly to the purposes and objectives of the composition project: identifying and using production and audio manipulation techniques. The students were instructed to continuously employ this mode whilst processing and composing with each sample. Figure 4 (below) shows the overall intentional usage of each audio ‘transformation technique’, as utilised by the students collectively over the course of the project.

Perhaps the most important pedagogical implication of this data relates to the sequence of the teaching and learning process. As discussed above, semantic listening was used to guide and support the students’ musical and technological responses (in terms of the techniques used, soundworlds explored etc.) and retrospectively utilising syntactical listening then allowed various analyses to be conducted. Technological listening, however, is applied continuously throughout the semantic and syntactical stages, but only begins once an initial semantically informed idea is conceived. I have devised Figure 5 to represent this concept visually.

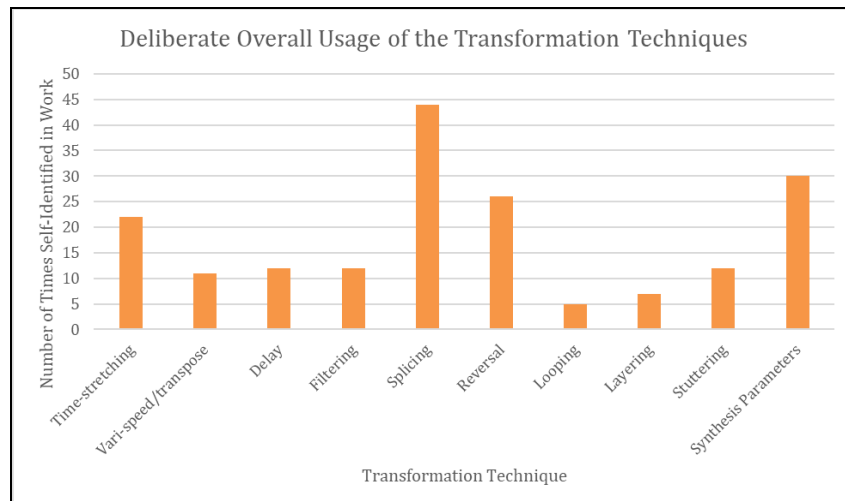


Figure 4: The overall deliberate usage of audio transformation techniques

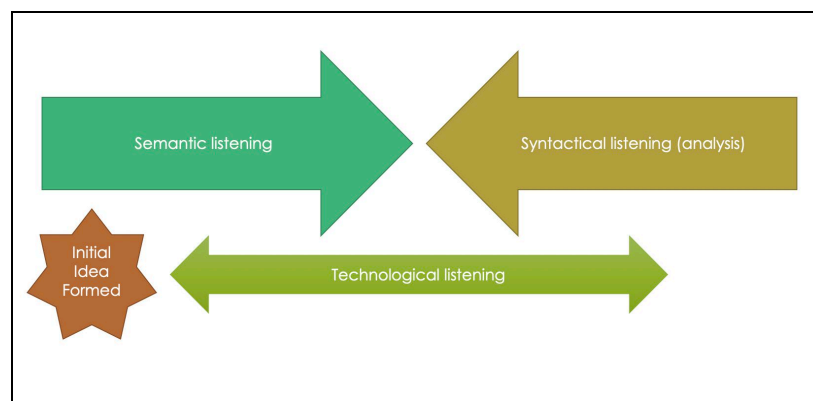


Figure 5: The pedagogical process categorised by listening modes

Students clearly outlined this process during the review presentations:

“I time stretched Sample 2 to create the sound of a machine rotating slowly” (Harry)

“Stuttering – I spliced section[s] out and looped them. This added a glitchy effect to the scene as it fit with the glitchy elements of the scene” (Aaron)

“There is also a spliced version of Sample 4 which reflects the crashing sound...” (Melvin)

“Sample 3...synthesis parameter[s] – I automated the filter frequency and the filter mode...so it could also be related to what sounds would be like in a factory” (Noah)

Students conceive of a semantically informed idea, are supported to realise their intentions technologically, and retrospectively analyse the compositional processes used (and in some cases, the musical elements) by employing the syntactical listening mode whilst listening to their own work. I have presented technological listening, therefore, as a facilitating mode which binds the

semantic and syntactical modes into a pedagogical process and, as thus, I have positioned the technological mode as integral to the very centrality of the listening experience itself (in terms of students listening continuously to their own work as they compose), in the context of supporting students creating sample-based compositions. Such a pedagogy allowed students' "pallets of sound" (Hill, 2018, p.54) to be expanded, due to both the centrality of the (technological) listening experience, and the subsequent engagement with the "microphenomena" of sound itself which follows as a result (Savage, 2007, p.73). The students' comments during the review presentations outlined this enhanced micro-sonic engagement:

"I...listen to music and sounds differently trying to pick out individual interesting sounds"
(Harry)

"... I will listen to sounds very differently...as I can understand what is happening rather than just hearing different random sounds" (Aaron)

"...now I listen to music differently as I can focus on the different elements which allows me to identify how these sounds were created or used" (Melvin)

"I...listen to the sounds differently now" (Noah)

Given that the pedagogical process outlined above is facilitated by the usage of the technological listening mode, students needed to be guarded against Bell's (2015) variously 'afforded' actions (p.55). Table 2 demonstrates how, within the *Reason* DAW, the taught audio transformation techniques correspond to Bell's variously afforded actions (see p.262 of this article for a detailed description of each action). During the coding stage, it was clear that Bell's actions did not go far enough to categorise all possible actions, and that a new category was required to describe those actions which are initially *protected* (hidden), but then *privileged* once the appropriate window is opened. For example, students who explored virtual sampler instruments in order to apply synthesis parameters to the samples were initially confronted with a window which allows them to conduct none of the required actions. However, once the students load up the correct sampler instrument, the majority of the actions are then *privileged* and *provided* (apparent by default). I term such actions *post-protections*: actions which were initially hidden from immediate view, but easily become privileged and or/provided. Such actions are indicated by an asterisk in Table 2 below.

Taught Audio Transformation Technique	Correlation with Bell's Variesly Afforded Action(s)
Time-Stretching	Protected
Vari-Speed/Transposition	Privileged and Provided
Delay	Protected
Filtering	Post-Protected*
Splicing	Privileged
Reversal	Protected
Looping	Prevented
Layering	Privileged
Stuttering	Prevented
Applying Synthesis Parameters to Samples	Post-Protected*

Table 2: The taught audio transformation techniques and their correlation with Bell's (2015) variesly afforded actions within the 'Reason' DAW

Perhaps utilising the semantically informed pedagogy outlined above allowed for Bell's initial stage of *presumption* to be met, since techniques were taught with continual regard for students' semantic intentions: students were explicitly taught how to perform the required transformation techniques within the *Reason* DAW in order to realise these intentions independently. Procedural pedagogies, therefore, provide students with the foundations upon which their compositions can be built, and perhaps limit the impact of many of Bell's less-afforded actions. For example, the students collectively explicitly referred to using 'reversal' 26 times, the second most commonly used transformation technique (see Figure 4 earlier), even though the action is protected.

Procedural pedagogies, therefore, eliminate many of the mediating effects of technology, and employing them in a semantically informed and syntactically analysed process may represent a method in which such pedagogies become creative and meaningful, rather than manifesting themselves as step-by-step instructions which students must follow. Table 3 below outlines how the pedagogies discussed above were implemented during this sample-based composition project.

Just as continually reading back one's own work is at the heart of any writing process in order to guard oneself from misprints and dull style, promoting the centrality of the listening experience is at the very heart of a potentially transformative pedagogy which supports students creating sample-based compositions by not only capitalising upon the unique and individual experiences of the students and personalising the technological and musical processes, but also by guarding them against Bell's notions of affordance. With a clear pedagogical process in place, how then did the students actually use music technology within the composition process in response to this strategy?

Pedagogy	Implementation by the Teacher (Presented Lesson by Lesson)	
Semantically Informed	Lesson 1	Students were introduced to the project, and planned how they would compose for each scene of the specific video, considering a range of semantic inferences at each point. The questionnaire revealed students' hyphenated musicianship and their existing experiences and perceptions of music. Listening activities immersed students in the electroacoustic soundworld.
	Lessons 2 and 4	Students further immersed into the electroacoustic soundworld during starter listening activity. At each processing stage, students were required to verbally relate their sound transformation techniques to the video elements identified on their scene plans (created during Lesson 1). The students were continuously questioned on the semantic intentions behind their processing decisions.
	Lessons 3 and 5	Students composed a given scene, using the transformation techniques learned during Lessons 2 and 4. The teacher modelled an exemplary compositional response, and explicitly outlined some of the semantic intentions behind the composition. The students were questioned about the modelled example to ascertain how the samples were structured to reflect the content of the video. Using their scene plans, students related each technological decision to a semantic reason.
	Lesson 6	Students planned scene three before composing this scene independently, in order to scaffold their technological processing around semantically reasoned observations from the video.
Procedural	Lesson 1	Students explicitly taught how to listen (equipping them with the skills to fully benefit from the listening-based pedagogies utilised), and about some of the possible mediating effects of technology. Use of music technology was discussed theoretically but not explored practically during this introductory lesson. Students were introduced to the composition brief.
	Lessons 2 and 4	Students were taught how to realise the sound transformation techniques. Each technique was introduced one by one, and then the students were able to immediately undertake the processing modelled by the teacher. Support throughout the lessons was based around the taught transformation techniques. At this stage, students were listening both technologically and semantically.
	Lesson 3 and 5	Students were taught the required transformation techniques during Lessons 2 and 4, with procedural pedagogical support from the teacher referring back to the realisation of these techniques.
	Lesson 6	Free composition of scene three. By this stage, students had acquired the technological and transformational skills required to independently compose, with their ability to use each technique becoming part of their general working knowledge.

Table 3: The implementation of semantically informed and procedural pedagogies throughout the sample-based composition project, derived from the research plan

How do students use music technology within the composition process?

In this section I present a summary of each student's use of music technology throughout the composition project, and conclude by discussing the emerging overall themes.

Harry

Throughout the entire project, Harry made use of 9/10 of the taught audio transformation techniques whilst processing and composing with the samples, with the only technique not used being ‘looping’. However, Harry instead made extensive use of ‘splicing’ by ‘carving out’ small chunks of audio and then arranging them into a kind of ‘sonic tapestry’, as represented by the number of vertical ‘splice’ lines present in Figure 6 below. It is worth noting that during the review presentations and in his commentary logbook, Harry was the most concerned with relating every compositional decision to an element of the video, when compared with the other students. Harry uses splicing to represent very specific moments in the video, and therefore examples of splicing are brief. Perhaps, therefore, the apparent lack of looping exemplifies a deliberate creative decision to exclude the technique on the grounds of him not finding an element within the video for which looping would be appropriate, rather than an accidental oversight on Harry’s part.

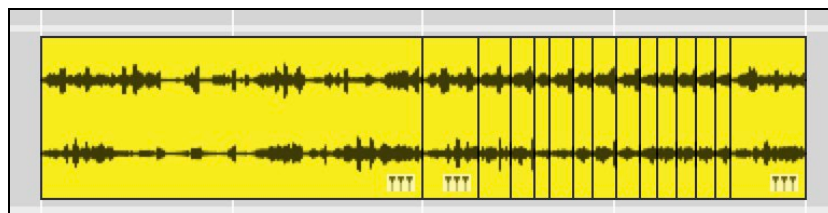


Figure 6: An example of Harry's use of 'splicing'

Aaron

Similarly to Harry, Aaron also made use of 9/10 of the taught audio transformation techniques whilst processing and composing with the samples, and ‘looping’ was once again the neglected technique. Instead of looping samples, Aaron uses ‘splicing’ to fuse different sections of the same sample into unnatural, and often lengthy sequences, which he layers vertically alongside other samples (see Figure 7 below where the blue arrow points to the spliced sample, and the other regions (boxes) represent the other samples in the composition). Such a usage of splicing implies that Aaron considers the purpose of splicing to be more akin to looping than to that of weaving a ‘sonic tapestry’ of sound, and suggests that Aaron utilises the technique to increase the length (quantity) of the samples, rather than to improve and explore their (sonic) qualities (Savage, 2007, p.70).

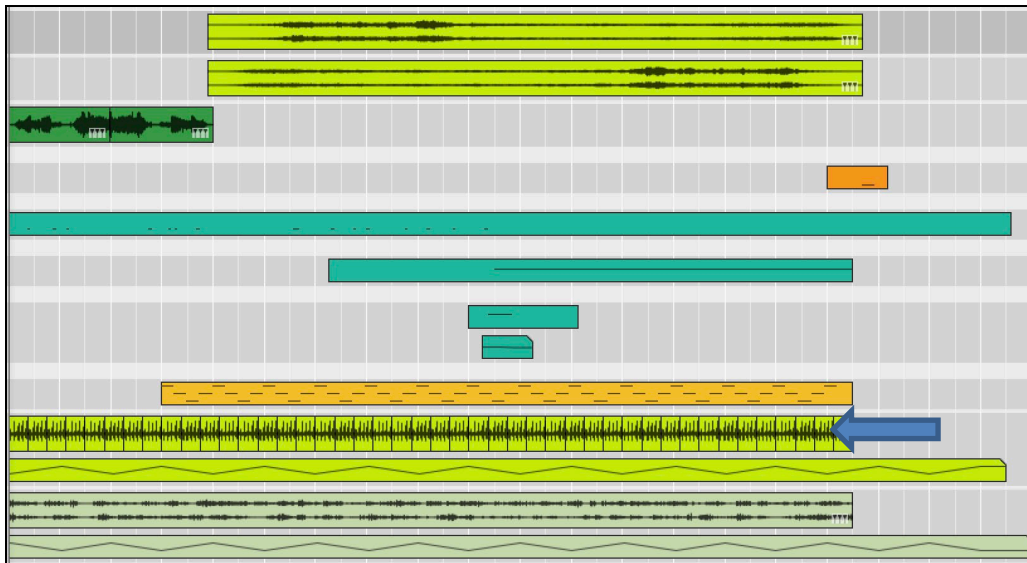


Figure 7: An example of Aaron's use of 'splicing'

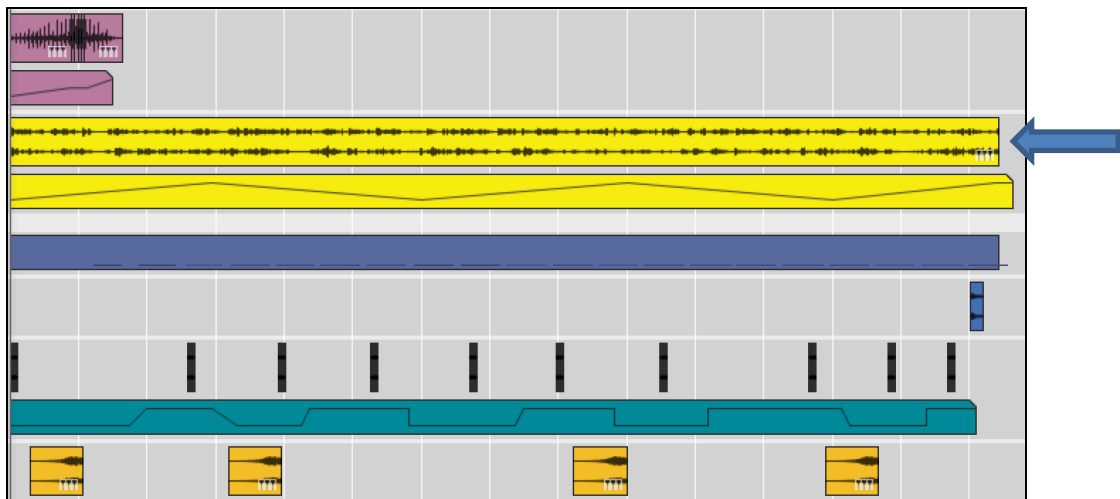


Figure 8: Melvin's compositional approach – shorter, more processed samples arranged around a continuous, lengthy sample

Melvin

Melvin was the only student who exploited all of the taught transformation techniques within his composition. This then enabled him to extensively explore additional techniques, as discussed in the next section. Melvin's compositions therefore exemplify the idealised outcomes expected by employing the semantically informed pedagogy outlined in the previous section. Like Aaron, Melvin created lengthy samples which function in a similar way to *ostinati* – short, perpetually repeating musical phrases - around which other semantically informed sounds are arranged (see Figure 8 above where the blue arrow points to the *ostinato*, and the other regions (boxes) represent

the other samples in the composition). This appears to summarise Melvin’s compositional and technological approaches: one continuous lengthy sample is created, around which other, more extensively technologically manipulated and semantically reasoned samples are introduced.

Noah

Noah made use of 7/10 of the taught transformation techniques, with ‘looping’, ‘layering’, and ‘stuttering’ being the techniques which he did not utilise. Interestingly, ‘looping’ and ‘stuttering’ are both actions which are initially prevented in the *Reason* DAW, and therefore the methodology of realising these two techniques is not as immediately intuitive as it is with many of the other techniques. ‘Layering’ requires sounds to be merged together, in order to create a new sound.

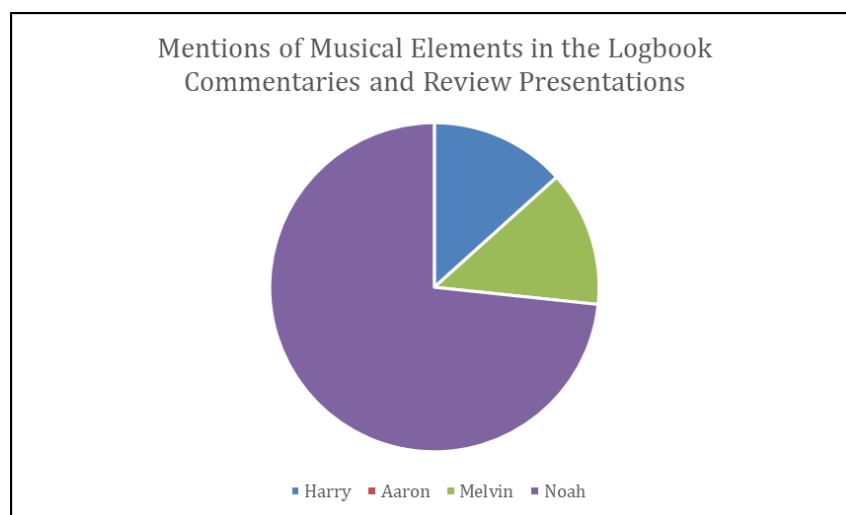


Figure 9: Students’ mentions of any musical elements in the logbook commentaries and review presentations

Noah, however, arranges different processed samples vertically, but does not do so in order to create original sound matter, suggesting that he uses the term ‘layering’ in its musical, rather than its technological, sense. It is worth noting that thematic coding of the logbook commentaries and review presentations revealed that Noah was the student who was most concerned with relating technological decisions to traditional musical concepts. Figure 9 (above) shows that 73 per cent of mentions of musical concepts, both in the logbooks and the review presentations, were accounted for by Noah. Aaron, on the other hand, did not reference musical concepts at all.

Overall themes

Firstly, it is apparent from the individual student summaries above, that Bell's (2015) notion of the *facile fallacy* – the misconception that music can be made effortlessly and immediately with music technology (p.53) – is indeed correct: using music technology to compose presents challenges to its users. For example, Harry struggles to perform some basic techniques; Aaron appears to find it difficult to distinguish between quality and quantity; Melvin adopts one singular composing strategy; and Noah avoids using techniques which are prevented and/or protected within the DAW. Perhaps the misconceptions surrounding the *facile fallacy* stem from loop-based projects, where students are simply arranging samples rather than processing and manipulating them, which is similar to Noah's approach to 'layering'. Arguably, comparing loop-based projects with processing-based projects introduces unnecessary divisions between the 'music' and 'technology' components of the subject, however utilising semantically informed technological processing seemingly ensures that the *facile fallacy* can be proved as being such, when cultivating the students' technological skills is the focus.

Next, Bell's (2015) variously afforded actions do not correlate as predicted with each transformation technique used by the students. At the beginning of the project, I hypothesised that the most commonly used transformation techniques would be those actions which are privileged and provided. Whilst this trend is true in some cases and, specifically for some students, some protected and post-protected actions are generally more commonly used than some privileged and provided actions, for example synthesises parameters and splicing (see Figure 10 below). This suggests that students' use of music technology need not rely on intuitive experiences, but rather on their technical skills which are cultivated and developed by the teacher. To define students' abilities by those skills which they already possess as digital natives (Savage, 2007, p.65) is reductive, since, in this case study, all of the students can be classified as digital natives, implying that other factors contribute to their overall use of music technology. Bell's theory of affordance simply does not go far enough to explain how students use music technology in compositional contexts: just because some actions are more intuitive than others does not mean that they, always, will be more commonly utilised.

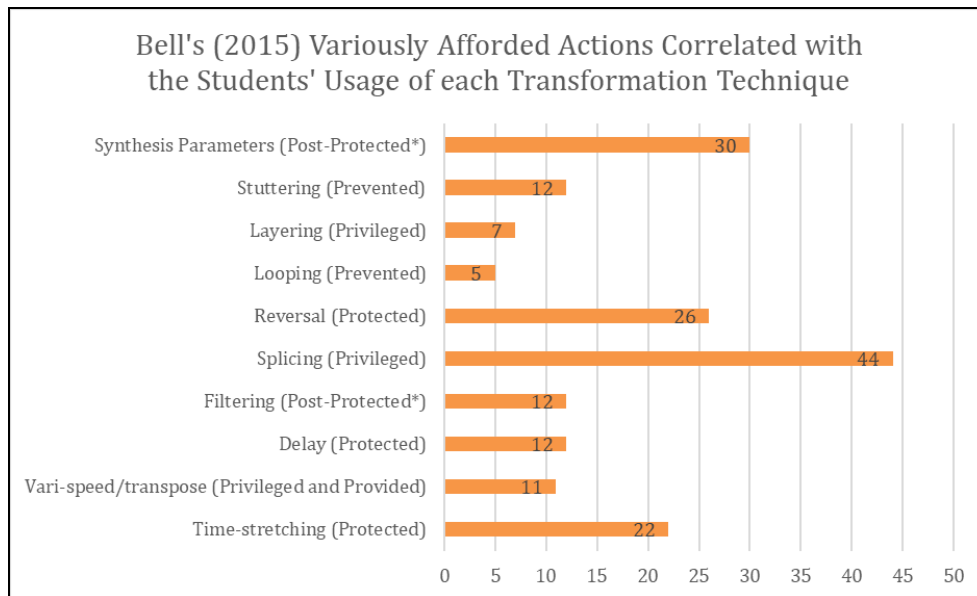


Figure 10: Bell's (2015) variously afforded actions correlated with the students' usage of each transformation technique

Finally, the composition project provided students with a *hybrid space* (Tobias, 2012), due to the students being able to adopt different roles, and use varied tools, techniques, and approaches throughout the project (p.342). Figure 3 (earlier) illustrated how each student in the study identified as a combination of performer, composer, and listener, but in varying proportions, yet all of the students thrived and produced unique and diverse compositions, suggesting that *hyphenated musicians* (Tobias, 2012, p.329) were catered for. In turn, this allowed students to use music technology somewhat idiosyncratically within the composing process to reflect their individual experiences of and with music: once the transformation techniques had been taught, students were then able to freely employ them, and retrospectively alter their compositional decisions. In electroacoustic music, the composer is also the performer – this role must be extended, since loudspeaker transmission is the prime medium through which electroacoustic music is heard -, and must also position himself as a listener to experience his work from multiple perspectives. The students described this phenomena of using technology as a facilitating vehicle used to veer between and across different roles; using technology allowed them to capture their scaffolded creative thoughts, ‘perform’ their work to themselves, and then utilise the listening role to evaluate their work:

“I use techniques like panning on each of my [tracks] to get a balanced mix... I [then] listen to... [the] sounds differently trying to pick out individual interesting sounds” (Harry)

“I ... use the techniques ... [and] listen to sounds very differently ... [so] I can understand what is happening” (Aaron)

“I ... use the techniques ... when composing ... [and] I listen to music differently as I can focus and listen to different elements” (Melvin)

“I ... use the techniques ... [and] listen to sounds differently” (Noah)

Students, therefore, use music technology within the composition process in a number of idiosyncratic ways, and their usage of music technology confirms that the *facile fallacy* is indeed a fallacy, that fostering the students’ different musical roles is essential to capitalise upon their own personal musicality, and that Bell’s (2015) variously afforded actions do not generally limit students’ realisation of technological processes. The students’ particular experiences exist due to the implementation of the semantically informed pedagogy outlined in the previous section, and their use of music technology is personalised and unique. How, then, do students extend and build upon the taught techniques within their personal explorations?

To what extent are the techniques used by students developed beyond teacher explanations into personal explorations?

One overall theme relating to students’ personal explorations of the taught techniques emerged during the coding process; students replicated the taught compositional process within their personal explorations, as evidenced by the students’ comments during the ‘scene three’ section of the review presentations:

“...I spliced and stuttered ... Sample 4 to [represent] ... machines clashing ... and [in] doing this ... I overlapped the different parts” (Harry)

“...I cut out waves and used them to make synth sounds. I used this to add a drone that lasts the whole scene....” (Aaron)

“Throughout there is a drone which was from Sample 3 as I spliced it down to one waveform” (Melvin)

“...I reversed Sample 1 ... [to create] a new sound, as well as it creating a long suspense sound...” (Noah)

During the project, students were challenged to compose for the third and final scene independently, without any teacher input. Whilst they demonstrated a desire to employ additional, non-taught techniques, the general compositional process remained identical for each student: the

samples were first processed and then arranged into a large-scale structure. Employing such a compositional process suggests that students were actively engaged with the microphenomena of the sounds they were working with, and that this scaffolded process allowed students to explore a broad “field of sound” (Hill, 2018, p.56) by engaging with and expanding upon each technique. This suggests that the students’ personal explorations were scaffolded – but not limited - by the semantically informed pedagogy outlined above. Figure 11 below illustrates the proportion of the students’ usage of the teacher-explained audio transformation techniques and the students’ usage of non-taught techniques. With 26 per cent of the technological techniques utilised throughout the project accounted for by students’ personal explorations, it is clear that the taught techniques are extensively developed by the students.

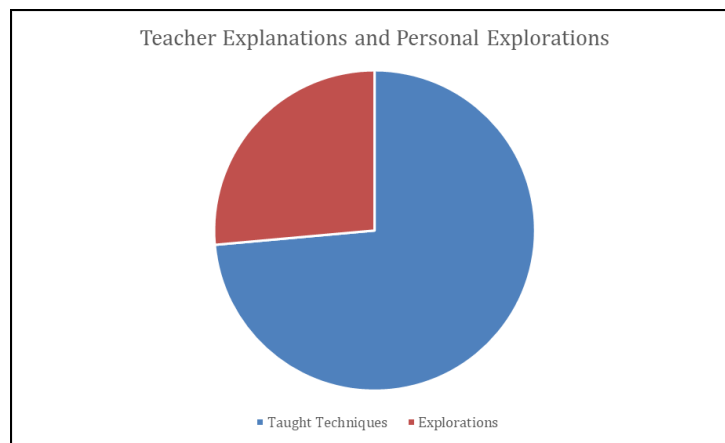


Figure 11: The proportion of the usage of taught transformation techniques and students' personal explorations

Figure 12 (below) shows each personally explored technique, defines its relation to Bell’s (2015) variously afforded actions (in the context of the *Reason DAW*), and specifies which students used the techniques and the frequency of their usage.

The act of developing the taught techniques – and utilising additional techniques - relates directly to the final stages of Macedo’s (2013) ‘five-step project’ (p.216), suggesting that once students are introduced to the theoretical and practical concepts of sound processing, they integrate these new concepts into general knowledge, adding them to their repertoire of technological processes. Macedo’s theory, however, is not extensive enough to explain how students use their existing repertoire to synthesise new technological processes: a phenomenon which clearly took place during this study. Perhaps some students’ personal explorations were simply ‘regurgitations’ of

processes already embedded within their general repertoire, yet some students' explorations were clearly extensions of the taught techniques. 'Resonance', 'ADSR', and 'advanced filtering' (see Figure 12) for example, are all examples of 'synthesis parameters', but were not explicitly taught to the students. 'Panning', 'reverb' and 'automation' on the other hand are potentially examples of techniques that the students were already competent at using, before the project began, which would account for their high frequency of usage.

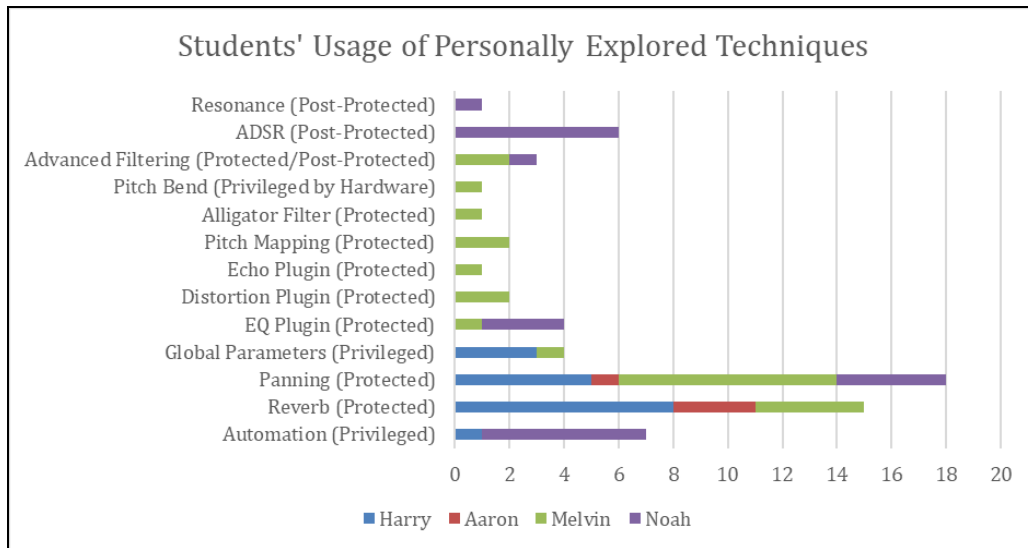


Figure 12: Students' usage of personally explored techniques

It is unclear whether students actively explored the taught techniques in order to extend their usage, or whether they regurgitated skills from their existing repertoires, yet, at the very least, the data supports that students actively seek to 'go beyond' what they are explicitly taught. It is clear, however, that personal explorations were not limited or mediated by Bell's (2015) variously afforded actions, since 10/13 of such explorations are either protected or post-protected within the *Reason* DAW. Perhaps, therefore, a semantically informed pedagogy equips students with the technical skills to realise such explorations, and Bell's (2015) protected and post-protected actions simply represent creative and technical challenges for the semantically informed student to overcome.

Limitations

The findings of this study must be considered in light of one main limitation: the study was interrupted by nationwide school closures due to the COVID-19 pandemic, and therefore the final

lesson, in which students independently composed for scene three, was conducted asynchronously, with students potentially able to spend as much time composing as they desired, before the deadline. Perhaps this could have led to increased examples of personal explorations being evident in the students' work, since they may have also spent considerable time retrospectively adjusting their compositions for previous scenes during this time. Each of the four students, however, had continued access to the *Reason* DAW, and therefore the students were able to use the same music technology software that was available to them at school. Students continued to receive teacher support and feedback during this time, through email correspondence and other 'virtual' platforms. Thus the way in which students used technology to compose sample-based music remained consistent across the project. Due to the first five lessons being completed under normal circumstances, the way in which teachers planned to support students composing sample-based compositions remained unchanged when compared with usual practices.

Conclusions

Using sample-based processes to compose electroacoustic music represents one approach to teaching and learning about (hyphenated) student-composers' utilisation of music technology. Music technology courses require students not only to be proficient music technologists, but also to be composers, in order to demonstrate technological skills in a meaningful and authentic format. Perhaps this demonstrates that indeed anyone can compose, if they possess the determination and desire to do so. Teachers, therefore, have a duty to utilise semantically informed procedural pedagogies which allow technological skills to be taught and related to the students' personal compositional and musical meanings. Employing such a pedagogy also allows the potentially limiting mediating effects of music technology to be transformed into creative challenges which can be presented to the students. As hyphenated musicians, students use music technology within the composition process initially to create sound materials, by processing the samples using a variety of taught and non-taught transformation techniques, and then to arrange and layer the different processed parts into a coherent structure, evaluating and critiquing their work at each stage. Students' aural evaluations and critiques relate to how successful their compositions are at representing specific, self-identified elements within the video, highlighting that their hyphenated musicianship flourishes within the hybrid space of the DAW, since they are able to freely explore and veer between and across a multiplicity of musical roles. Positioning students as hyphenated

musicians working within the hybrid space provided by the DAW facilitates extensive development of the taught techniques, allowing students to broaden and strengthen their skills through personal explorations. Adopting such a position also allows students to engage with the microphenomena of sound itself.

Students enter the music technology classroom with varied and unique experiences, and ultimately with different needs and expectations. Each student will have a different reason for studying the subject, but for all music technology students, the goal of study will be, in part, to support other areas of their broader musicianship. This highlights the importance of this study: how we, as teachers, encourage and privilege students' use of technology shapes their broader musicianship. Whilst this study has highlighted some of the ways in which students use music technology to compose using sample-based processes (in line with the exam board's specification), the issue of how students subsequently employ the taught transformation techniques, alongside those techniques which were utilised due to personal explorations, both within additional classroom contexts and during the pursuit of broader techno-musical competencies, requires further research. Perhaps a semantically informed pedagogy can be applied to future projects and teaching, not just in terms of composition but also to the sequencing and multitrack recording components of music technology courses. Not only might this improve students' technical skills, but also provide a framework within which they can relate their course of study to their broader goals as student-musicians. Further research into the semantically informed approach is clearly required, both within the context of the music technology classroom, and within the wider context of music education more generally. Perhaps such a pedagogy would also be impactful if applied to other arts subjects in which students' creative outputs need to be to be loosely guided by the teacher and become personally meaningful to the student.

Word processors are curious applications which provide their users with the space to create, yet still present challenges and limitations, which the creative user must overcome. They are essential to varied modern practices, with their resulting products present across the globe, however, word processors would never be credited for the authorship of the literary content itself. The impacts of music technology are equally as radical – technology is fundamental to the creation and distribution of modern music. Its users – and students of the discipline – should be credited as being 'musical-technological' geniuses, just as some authors are credited as being literary geniuses, since it is the

human skill, creativity, and determination behind the work of art – as exemplified by the students in this study - which deserves commendation, not the technology itself.

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