

10 Studying Hybrid and Electronic Drum Kit Technologies

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Introduction

The drum kit exists as a result of significant technological innovations and developments that have influenced the design and manufacture of its constituent parts. The drum kit can be defined as a technology in itself, in that it is a device that exists and functions as a direct result of ‘the practical . . . use of scientific discoveries’.¹ The technological developments of the traditional acoustic drum kit have been recorded and described in articles in periodicals such as *Modern Drummer* (Modern Drummer Publications) and *Rhythm Magazine* (Future plc), and are comprehensively charted in Matt Dean’s book, *The Drum: A History*.² Additionally, Matt Brennan (Chapter 1 in this book) provides a short historiography of the technological development of the drum kit in which he states that the definition of the drum kit is continually ‘in flux’; arguably, this has never been more true considering recent developments in electronic drum kit technologies and how they are used in performance by drummers.³

In this chapter, however, I have chosen to be mindful of the use of the word *technology* when discussing the modern drum kit setup, as the description of the drum kit as a technology may not be recognisable to many contemporary drummers. My choice is predicated on the growing use of the word technology to describe the electronic devices that permeate our every-day life. In this chapter the word technology will only be used in the context of the electronic technologies used to augment, or replace, the acoustic drum kit. ‘Technology has vastly extended the drummer’s sonic palette’ and in many cases, technology has also augmented the role of the drummer within their performance settings.⁴ These technologies include percussion controllers, sample pads, triggers, and music creation software(s) that are now commonly used to augment, or even replace, the traditional drum kit setup.⁵

This chapter seeks to open the discussion about how drum kit educators might embrace drum kit technologies as an exciting and highly relevant part of their curricula. Through examination of the experience of students studying my own drum kit technologies course, this chapter

will propose ways in which educators might consider supporting their students to explore these technologies and develop valuable skills and knowledge by situating them at the heart of their student's creative music making.

Situating the Drum Kit in Popular Music Education

This chapter is firmly situated in Popular Music Education, an emerging and expanding field of music research.⁶ Courses in popular music in higher education (HE) have only existed for around three decades and as such, educators are still developing teaching approaches that provide recognisable, valuable, effective, personalised and authentic experiences for their learners.

Drum kit is taught across a range of popular music performance courses at HE level, with tutors drawing on a series of long-standing approaches and methods to teach the instrument.⁷ However, the learning opportunities drummers might experience during their studies may vary based on: (1) the level at which they are studying; (2) the tutor with whom they are studying; and (3) the course they have selected to study. Most drum kit curricula have been designed based on what the tutor decides is valuable with some degree of personalisation for each student.⁸ Some courses will teach drum kit as an ensemble instrument with no, or limited, one-to-one tuition. On other courses students may receive a weekly one-to-one lesson, and in some cases, drum kit is taught to groups using electronic drum kits which have the same setup and layout as an acoustic drum kit, with each drummer wearing headphones.

From my own experience working as a drum kit specialist in HE, it is rare that drum kit curricula include teaching the creative use of drum kit technologies. In this chapter, I examine student perceptions of learning these technologies as part of their undergraduate studies at Edinburgh Napier University, Scotland. I explore the benefits of studying this course, the challenges students encountered, and discuss the implications of these findings for future course and technology development.

Teaching Electronic Drum Kit Technologies

Since 2008, I have been running a compulsory course that teaches drum kit technologies to drummers in Year 3 of the BA Popular Music degree programme at Edinburgh Napier University, Scotland. Drummers

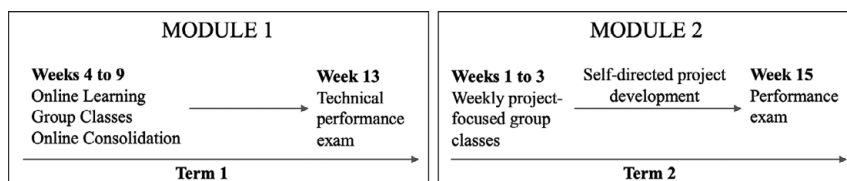


Figure 10.1 The arrangement of the drum kit course within the two-performance module structure

embarking on this course are performing at approximately London College of Music Diploma level, have studied at least two modules in music technology and have developed skills in music analysis.⁹ This prior experience equips students with the prerequisite skills to engage effectively with the learning on the course. The course has been designed to explore the full affordances of drum kit technologies, to provide students with a skill set that will support their creative and musical activity, and to produce versatile graduate drummers who have increased chances of employment in the music industry.¹⁰ From a music industry perspective, it is now commonplace for drummers to integrate technologies into their setup, therefore it is important that students have the opportunity to develop knowledge and understanding of drum kit technologies to enable them to perform the production-led music they aspire to play.

The course straddles two modules (Figure 10.1). In Term 1 students learn the functionality of the technologies then engage in a series of practical tasks and creative performances.¹¹ The initial section of the course occurs across a six-week block. The curricular content is delivered using a flipped classroom methodology.¹² Each week, students engage in online learning prior to class, participate in practical face-to-face group workshops, and engage in online individual and group consolidation activities. The primary drum kit technology used on this course is the Roland SPD-20 percussion controller.¹³ There are a number of reasons for this selection:

- the simplicity of the user interface;
- the ability to layer two MIDI notes on different MIDI channels on each pad; and
- the controller is prevalent in contemporary popular music, the focus of the BA Popular Music programme.

In the initial weeks, students cover the following topics: accessing and editing sounds; acoustic and electronic drum triggers; the MIDI functions of the percussion controller; and connecting the controller to computer-based music software to access sampler instruments.¹⁴ At the end of the first term students are assessed on their performance of a set work for solo hybrid drum kit.¹⁵

In the second term students develop a solo performance to be played using only drum kit technologies and music software. The process of developing these performances requires students to:

1. analyse and describe their chosen song;
2. record, program, produce, and deconstruct the arrangement they will perform;
3. learn a new notation method and produce a score of their performance; and
4. develop a different approach to coordination that is driven by the complexity of musical arrangement which embraces both the affordances and the limitations of the technology.

Stages 1 and 2 above require students to analyse the music they are creating from multiple perspectives including melody, harmony, rhythm, texture, timbre, and from a music production standpoint. To successfully analyse and reproduce the music they want to perform, students need to understand the stylistic characteristics of the music, and the production techniques employed in the recordings. At this stage students are also analysing timbre – ‘all that is left after pitch and dynamic level’.¹⁶ The students deploy analysis skills to examine timbre to then accurately recreate sounds and produce quality reproductions of their chosen songs. Tutor support is offered at this stage, but in line with observations made by Tobias, students on this course regularly develop their production skills through researching and viewing online videos.¹⁷

Drivers for This Current Research and Method

Module-level feedback has always highlighted that students value the opportunity to learn these technologies as part of their studies. However, the feedback rarely provided detail, depth, or context on the learning experience. I chose to conduct qualitative research to gain a deeper understanding of the student experience on the course to ensure that the learning experience was relevant, valuable, and delivered effectively. I conducted semi-structured interviews with twelve drum kit students (two female and ten male) from Year 3 and 4 of the BA Popular Music course. Seven students studied the drum kit technologies course in 2017–2018 and five students studied the same course in 2018–2019. Three students had never used these technologies before and of the remaining nine students, the majority had used electronic drum kits as a direct substitute for an acoustic drum kit. All students had experience of using Logic Pro X, the music software used in this course. Interviews were recorded (with permission) and were fully transcribed. I scrutinised the transcripts and conducted a thematic analysis to identify emergent themes.

Research Findings and Discussion

The analysis of the transcripts exposed the following four themes:

1. The learning and teaching experience
2. Working with notation and developing coordination
3. Employability
4. Desired course developments

Learning and Teaching Experience

The findings indicate that participants valued the opportunity to learn drum kit technologies. The student learning experience in Term 1 can be categorised into four distinct learning activities: (a) online class preparation; (b) face-to-face groupwork in class; (c) online consolidation activities; and (d) the preparation and completion of a summative assessment. In particular, participants felt that the flipped classroom approach used to structure and deliver learning experiences was of significant benefit to their engagement and understanding of the weekly topics.¹⁸ The online learning activities enabled students to prepare for class, increasing their confidence in the use of these unfamiliar technologies.

It meant that you could do it [learn] at your own pace so you could pause videos instead of taking up class time . . . if you watched all the videos everything you needed to know was all in those videos . . . It also meant that if you forgot something, then you could go back. Participant 4 (Year 3)

It was like having a one-on-one lesson with you [the tutor] that never ended because we were able to go back and double check everything. If there was a bit that we didn't understand, we were able to rewind . . . It gave me the knowledge on a one-to-one basis at a time and place, and pace that suited me best. Participant 6 (Year 3)

The comments received in relation to the preparatory activities highlight that the use of video demonstration was highly effective in enabling learners to develop a deep understanding of how the technologies function. This approach mirrors the way in which many instrumentalists use online video streaming services such as YouTube or Vimeo, or specialist instrumental education sites such as Drumeo, or video created by their tutor in formal, non-formal and informal contexts.¹⁹ The asynchronous nature of this online delivery had a positive impact on student learning, enabling students to study and review materials at their own pace, at a time that suited their schedule.²⁰

Traditional acoustic drum kit tuition does not suit group teaching settings for a variety of reasons, for example, only one person can play

the kit at a time and the volume and space considerations of having more than one kit in a room. These issues are somewhat mitigated when using drum kit technologies as their volume can be controlled, the equipment often occupies a smaller physical space, and if resources allow, multiple drummers can be playing and learning in the same space.²¹ This approach can be seen in many institutions where rooms are filled with electronic drum kits set up in rows facing the teacher. However, this approach does not necessarily support what Lave and Wenger describe as a 'community of practice' or promote collaborative learning, since the drummers are working individually.²² In this setting, the in-class activity is not predicated on sharing or co-creating knowledge, or collective problem-solving. A significant difference in the way my course is delivered is that there is very little tutor direction in group workshops. Students collaborate to complete a series of tasks and share their learning and understanding in the group. This enables the students to enter what Vygotsky describes as the 'zone of proximal development' i.e. the collaborative learning environment enables students to develop a deeper understanding of the equipment compared to completing the tasks individually.²³

They [group classes] were really good in terms of other people coming up with questions . . . all of us basically are teaching each other and learning from each other's mistakes and problems. Participant 3 (Year 3)

I really enjoyed it because it was collaborative . . . If one of us figured something out, the environment was tailored to enable us to share that . . . it tended to be that someone would experience a problem, and once we found the solution, the whole class would know. Participant 12 (Year 4)

Following workshop classes students engage in a range of online consolidation tasks, some of which are used to develop a community of inquiry.²⁴ The tasks included: sharing videos that demonstrate the skills developed in the previous class; writing research-led collaborative blogs to explain the functionality of certain technologies to the class; and sharing research into drummers who use technology in live performance. Students recognised that by completing each task they deepened their knowledge and increased their confidence in using these technologies.

It was like a recap on what we had gone through in class. It obviously gave you [the lecturer] confidence knowing that we could do it [in class] and then go away and do it again. Participant 9 (Year 4)

It was very important that the tasks we were set were determined on what we had learned in class . . . and being able to show what you had done in your own time to everyone else was pretty cool. Participant 7 (Year 4)

Working with Notation and Developing Coordination

Approaches to scoring music for hybrid drum kit so far have negated to include directions for coordination and assume that the learner will be able to ‘work it out’.²⁵ This may be the case if the coordination required to trigger the electronic sounds is an obvious substitution for elements of an original groove. For example, Example 10.1 shows notation of a simple hybrid performance. The pad strike in bar 2 is played using similar coordination to that used in bar 1.

Most drummers would be familiar with the coordination required to play the groove in Example 10.1, and the process of substituting a different sound source on beat one is similar to the coordination used to play the crash cymbal when introducing a new section of an arrangement. However, if the coordination is not clearly mapped for the learner, there is always a chance that the coordination they apply will not be the most straightforward or efficient. In Figure 10.2, the coordination used to perform the pad strike may seem obvious – for a right-handed drummer the pad could be played by the right hand in substitution for the hi-hat. However, it could just as easily be performed with the left hand allowing the drummer to also play the hi-hat on beat 1 of the second bar. Clear signposting of the required coordination is vital to ensuring economy of motion and to allow as much of the existing or underlying groove to be maintained.

A key feature of this course is that drummers learn a notation system specifically for electronic drum kit technologies. This notation system can represent the coordination, rhythmic phrasing, and the pad numbers that are to be struck to activate sounds (Figure 10.2 and Example 10.2).

This notation method has been highly effective in supporting the process of learning and sharing music, so much so that students have learned the notated performances without actually practicing on the technology. Students often use a piece of paper with the SPD-20 layout drawn



Example 10.1 Hybrid drum kit notation showing pad strike substitution for the hi-hat in bar 2

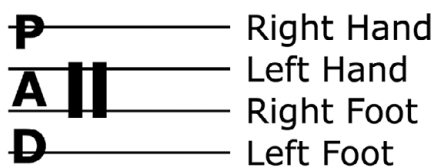


Figure 10.2 The PAD notation clef and legend



Example 10.2 Notation of a hybrid performance. The left hand is used to trigger the electronic elements of the performance

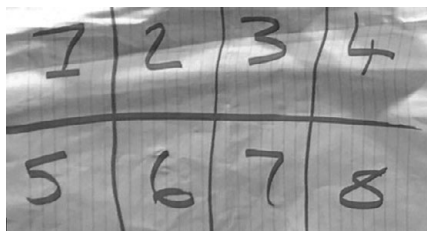


Figure 10.3 The hand-drawn layout of an SPD-20 used by a student to learn a hybrid performance

on it and learn the coordination required by tapping the numbers in the grid to familiarise themselves with the patterns (See Figure 10.3).

Using the PAD notation, students were able to quickly learn the coordination required to perform new pieces.

I really liked it. I thought it was brilliant, I have never seen anything like it. It's unique. I think each limb having its own line on the staff really works.
Participant 9 (Year 4)

It was quite easy to read, it also just . . . makes sense. I hadn't seen any pad notation before, it was good. Participant 10 (Year 4)

When we examine the educational publications that focus on developing coordination and dexterity, almost all are predicated on developing these skills in relation to the acoustic drum kit setup.²⁶ Hybrid and fully electronic performances provide an alternative way of developing coordination. Cameron suggests coordination, and creative performance, can be developed through reallocating patterns with grooves to different limbs on the traditional drum kit.²⁷ When drummers use drum kit technologies to activate melodic, harmonic and/or rhythmic elements of a piece, performances will require non-standard coordination that will rarely be recognisable as a groove or fill. In fully electronic performances any limb can activate any sound which greatly enhances the opportunity to manipulate and develop coordination. For example, to increase challenge, drummers might make significant use of their non-dominant hand to trigger parts of the arrangement. Additionally, increasing the rate at which sounds are triggered can make the performance more difficult. Changes made to these variables can pose significant challenges to the coordination of drummers

who have only learned patterns on acoustic kit. For many, integrating electronics often feels like playing two instruments (or more) at a time. During the interviews it was clear that students recognised that their coordination was challenged and that it improved as a result of performing the set work.

The conceptual challenge of playing drum kit differently, or of utilising technology for performance, which I don't think any of us had previously done, changes the way you think about your parts. Suddenly you are not thinking about drum beats you are thinking about musical parts that have to be played and from a coordination standpoint technically you are changing what you do with your body. Participant 12 (Year 4)

The coordination was probably the hardest part for me . . . It definitely got you used to wrapping your head around the completely different way you have got to approach actually playing . . . Once you have got your head around the coordination, playing grooves whilst playing the added sounds in amongst that, you are kinda set to do anything you want when you are just solely [playing] on the electronics. Participant 3 (Year 3)

Employability

Although electronic drum kit technologies emerged in the late 1970s, they have only recently started to feature in the kit setups of a significant number of drummers. Several factors have influenced this growth, such as: lower relative cost of purchasing equipment; the greater choice of products available to drummers; an increased expectation that highly produced sounds are replicated in live performances so that artists 'sound like the album'. As an educator based in the HE sector, there is significant pressure to produce employable graduates.²⁸ This expectation greatly influenced the development of this course. Students felt that the course enhanced their employability and furnished them with vital skills for their future career.

I've been hired to perform as part of a pit band for a musical and the whole premise is that I will be using a sample pad alongside the kit I'm playing the kit, percussion, sound effects or samples that they need. It just gives you another notch on your belt. It's another bullet point on your CV . . . in the modern climate of what music is, electronics are very important. Participant 6 (Year 3)

It's done a lot for it [employability]. Every band that you see playing anywhere there's not a drummer who doesn't have a sample pad or trigger here and there. I think it's vital for drummers going forward to be able to use this stuff . . . not being able to program something stops you from being able to play almost every song that is in the charts right now. Participant 4 (Year 3)

Desired Course Developments

The current course expects students to demonstrate their use of the technologies in solo performance settings. A number of students discussed their desire to explore the use of technologies in band settings. Using solo performances with technology as the focus for the course ensures that the learners understand, explore and demonstrate the technology's full potential. However, it is understandable that students would want to learn to use it in settings where they will most likely use it in the future.

It might be worth . . . using it [percussion controller] in more of a live setting . . . having like a hybrid acoustic kit and then triggering clicks and samples . . . I feel like the Spitfire piece in the first trimester probably benefited me more than the second trimester piece that we had to do, only because I have not been in a situation where I have had to use it [SPD-20] as a MIDI controller and make all my own stuff [samples] even though I think it is so beneficial. Participant 2 (Year 4)

While the notation method used to communicate the physical coordination, rhythmic phrasing and pad numbers is clearly effective and enables students to learn pieces quickly, students described their experience of checking the accuracy of their own PAD scores using the notation software as challenging.

The only thing I wish is that you can actually hear [the samples produced by Logic X] . . . when you are playing it [the score] in Sibelius, it was crazy . . . If you could choose each of the numbered sounds even if it wasn't what you were actually programming. If you could choose something that was kinda close I think that would be really useful cause you had no idea if you had put it all in right just by looking at this page of numbers. Participant 1 (Year 3)

The problem experienced by this student defines one of the key challenges associated with the scoring and playback process. Traditional scoring software provides a visual representation of programmed MIDI information. The software uses MIDI information to play back the specific pitch or tone that is notated (melodic or harmonic), or mapped (drums and percussion), i.e. each piece of notation links to a specific pitch or sound for the duration of the score. The numbering system used in the PAD notation only gives a visual representation of the pad to play, the coordination to be used and the rhythmic phrasing. The score does not produce MIDI information that maps directly to the sounds used across an entire performance as the sounds that need to be activated are constantly changing based on the patch.

The PAD score has to be generated by typing in the pad numbers on the music scoring software. Currently it is impossible to capture a live

performance that will automatically map directly onto the PAD music notation in the scoring software. This is because the additional information needed to produce the score, pad number and the limb it is played with, is not represented by a MIDI message and therefore cannot be recorded in the scoring software.

Reflection

Based on the research findings presented, this course is clearly deemed as valuable by students in that they feel they are learning important skills that will support their future career. Much of the music that these students play and listen to is production-led and many of them are turning to technology to extend the sonic palette available to them, recreate sounds produced in the studio, and in turn, enhance their role within their bands. Students recognised that the tasks set for summative assessment posed significant challenge and encouraged them to learn and make use of the technology in ways that stretched their abilities as a drummer, producer, and arranger of music. It is evident that they feel the learning experience is valuable not only in terms of their development as a drummer, but also in terms of the development of wider skill sets relating to group work, autodidactic learning practices and problem solving. The learning and teaching methods used to support the delivery and consolidation of core knowledge have motivated and enthused learners to engage with complex and somewhat abstract concepts. The course has provided an opportunity to explore these concepts to a deep level within a structured curriculum that scaffolds learning and provides opportunities for personalization.²⁹ The learning experiences in Term 1 enable students to develop an understanding of, and familiarity with, the PAD notation system. This approach ensures that when students create their own PAD scores, they are able to accurately capture the coordination and pad positions required to recreate a performance of their chosen song.

Performances using drum kit technologies in hybrid and fully electronic settings pose significant challenge to the coordination that these students have developed on the traditional acoustic drum kit. This is an exciting finding, as this alternative approach to teaching and developing coordination may provide a new avenue for drummers to develop what Cameron describes as 'multi-dexterity' and freedom of movement that can affect improvement in all areas of their drum kit performance.³⁰ The change of mindset students experienced when performing in hybrid settings where they are now playing a *new* instrument is an interesting finding that requires further examination and research.

Student responses identified opportunities to further develop the course and explore other ways of using the drum kit technology. In particular, the findings suggested that two parts of the course need to be examined: (1) the setting of performance tasks that mirror how the technology is commonly used by drummers in industry and (2) how the PAD notation might be manipulated to activate the correct sounds in the music software.

Point 1 is straightforward to address through course revision. It is clear that students are keen to explore ways in which they might use the technology in more recognisable performance settings that might enable what Joseph Pignato describes as ‘identity expression’ and ‘idiosyncratic purposeful creation’, where students have the freedom to use the technology in their own desired musical setting.³¹ Reflecting on the feedback, providing an opportunity to explore how student choice can be factored into the course design is an exciting prospect. Performing with technology in a band setting has been largely neglected based on the assumption that by studying the course as is, and through developing the advanced skills required to address the needs of the solo hybrid and fully electronic performance assessments, students will have covertly developed the skills to use the technology in an ensemble.

Point 2 presents a set of more significant challenges. Firstly, capturing a performance through the recording of MIDI information would not be possible as the MIDI note that is recorded for a single pad varies based on the active patch. Therefore, the scoring software would represent the pad differently each time the patch changed. The information that needs to be captured by the software is the pad number and the limb to be used to activate it. However, this problem poses an exciting challenge as no manufacturer currently offers a feature that enables the pad number to be captured by the software during recording. If this problem could be overcome, the information captured during a MIDI-based recording would be an accurate representation of the performance.

Secondly, the challenge of being able to check the accuracy of a PAD score presents a complex, but not insurmountable, problem. If there was a way to use the programme change information to alter the MIDI notes output by the software, then it would be possible to play back the correct sounds using the PAD software score. This could be achieved through the use of an intermediary software program that enables MIDI note information to be remapped to a different note number based on Program Change information (Figure 10.4).

The drum kit has evolved and extended to meet the needs of the musics in which it is used. Drum kit technologies now enable drummers to accurately replicate the sounds heard in recordings and to extend the creative and musical possibilities of the instrument. With any development

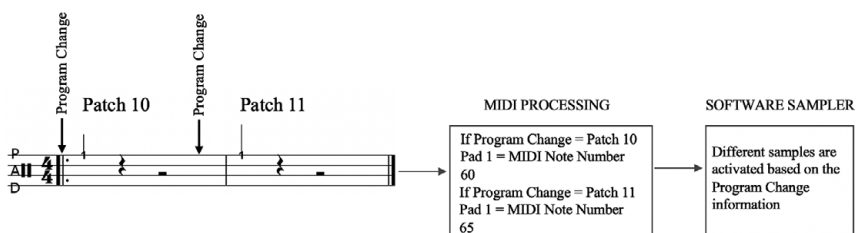


Figure 10.4 How MIDI signals generated by a software score could be processed to activate the correct samples in a software sampler

of the drum kit, we witness an advancement of the technique(s) associated with said development; for example, the development of the bass drum pedal has spawned techniques such as heel down, heel up, slide, swivel and heel-toe. The associated pedagogies then follow, with educators developing methods of teaching and sharing said techniques. We are now in an era where teaching the fundamentals of technique and musicianship are still central to a drummer's development, but as educators responsible for training and mentoring the next generation of drummers, drum kit technologies provide a new and exciting area of study to explore in our curricula.

Notes

- 1 'Cambridge Online Dictionary', *Cambridge Dictionary online*, available at: <https://dictionary.cambridge.org> (accessed 6 September 2019).
- 2 M. Dean. *The Drum: A History* (Plymouth: Scarecrow Press, 2012).
- 3 M. Brennan. 'The Drum Kit in Theory' in M. Brennan, J. Pignato, and D. Stadnicki (eds.), *Cambridge Companion to the Drum Kit* (Cambridge: Cambridge University Press, 2021).
- 4 B. Bruford, *Uncharted: Creativity and the Expert Drummer* (Ann Arbor: University of Michigan Press, 2018)
- 5 Percussion controllers would include Roland SPD-20, MIDI KAT, Alesis Performance Pad Pro. Sample Pads would include the Roland SPD-SX, Yamaha DTX 12 Multi, Alesis Sample Pad Pro. Triggers are defined as either stand-alone pads, or piezo/force sensitive resistant devices, that enable a stick strike on either a pad or drum to be converted into a signal to trigger a sound. Music creation software could include software packages such as Logic Pro X, Pro Tools, or Ableton Live.
- 6 For further detail see, G. D. Smith, Z. Moir, M. Brennan, S. Rambarran, and P. Kirkman. 'Popular Music Education (R)evolution', in G. D. Smith, Z. Moir, M. Brennan, S. Rambarran and P. Kirkman (eds.), *The Routledge Research Companion to Popular Music Education* (Abingdon: Routledge, 2017), pp. 4–13.
- 7 For further detail see, M. Dean, 'The Drum: A History', pp. 362–365; G. D. Smith. *I Drum Therefore I Am: Being and Becoming a Drummer* (Farham: Ashgate, 2013).
- 8 For a wider discussion of drum kit curriculum design see, B. Stillie. 'When Is a Drummer Not a Drummer? Developing Coordination, Musicianship, and Creativity through Electronic Drum Performance', in Z. Moir, B. Powell, and G. D. Smith (eds.), *The Bloomsbury Handbook of Popular Music Education: Perspectives and Practices* (London: Bloomsbury, 2019): p. 189.
- 9 LCM provide a series of graded instrumental exams. Entry to the Edinburgh Napier University BA Popular Music programme is set at Grade VII, which is two levels below the Diploma. Students will have studied foundation courses in Logic Pro X and Pro Tools. Music analysis skills in this context relate to using notation and aural skills to define and describe melodic, harmonic, textural, and rhythmic elements of music.

- 10 G. D. Smith. 'Popular Music in Higher Education' in I. Papageorgi and G. Welch (eds.), *Advanced Musical Performance: Investigations in Higher Education Learning* (Farnham: Ashgate, 2014), pp. 33–48; D. Bennett and R. Bridgstock. 'The Urgent Need for Career Preview: Student Expectations and Graduate Realities in Music and Dance', *International Journal of Music Education* 33:3 (2015), pp. 263–277.
- 11 For a detailed description of this course see, B. Stillie, 'When Is a Drummer Not a Drummer?', pp. 187–201; B. Stillie. 'Electronic Solo Performance Using Drum Kit Technologies' in A. P. Bell (ed.), *The Music Production Cookbook: Ready-Made Recipes for the Classroom* (Oxford: Oxford University Press, 2020).
- 12 J. Bergmann and A. Sams. *Flip Your Classroom: Reach Every Student in Every Class Every Day* (Eugene, OR: International Society for Technology in Education, 2012).
- 13 The Roland SPD-20 forms part of the Roland OCTAPAD range. The SPD-20 is a single unit that has an eight-pad playing surface, hundreds of inbuilt sounds that can be layered (two per pad), the option to connect external triggers via TRS cables, and MIDI connectivity.
- 14 Sampler instruments enable playback of audio files via MIDI.
- 15 Hybrid drum kits combine the traditional acoustic drum kit setup with electronic drum kit technologies.
- 16 E. S. Tobias. 'From Musical Detectives to DJs: Expanding Aural Skills and Analysis through Engaging Popular Music and Culture', *General Music Today* 28:3 (2015), pp. 23–27 and 25; E. I. Dolan. *The Orchestral Revolution: Haydn and the Technologies of Timbre* (Cambridge: Cambridge University Press, 2013), p. 54.
- 17 Tobias, 'From Musical Detectives to DJs: Expanding Aural Skills and Analysis through Engaging Popular Music and Culture'.
- 18 D. R. Garrison and H. Kanuka. 'Blended Learning: Uncovering Its Transformative Potential in Higher Education', *The Internet and Higher Education* 7:2 (2004), pp. 95–105.
- 19 R. Cremata, J. Pignato, B. Powell, and G. D. Smith. 'Flash Study Analysis and The Music Learning Profiles Project', *Action, Criticism, and Theory for Music Education* 15:5 (2016), pp. 51–80; G. D. Smith, 'I Drum Therefore I Am: Being and Becoming a Drummer'; N. R. Garner. 'The YouTube® Effect: A Paradigm Shift in How Musicians Learn, Teach and Share?' University College London, available at: <http://discovery.ucl.ac.uk/10026223/1/PrintCopyFinalThesis26092017NRG.pdf> (accessed 1 September 2019); K. Zhukov. 'Exploring the Role of Technology in Instrumental Skill Development of Australian Higher Education Music Students', *Australian Journal of Music Education* 2 (2015), pp. 66–77; L. Green. *How Popular Musicians Learn: A Way Ahead for Music Education*.
- 20 M. J. Hannafin. 'Inter-Action Strategies and Emerging Instructional Technologies: Psychological Perspectives', *Canadian Journal of Educational Communication* 18:3 (1989), pp. 167–179; D. R. Garrison and T. Anderson. *E-Learning In the 21st Century: A Framework for Research and Practice* (London: Routledge, 2003); Garrison and Kanuka, 'Blended Learning: Uncovering its Transformative Potential in Higher Education'.
- 21 This is a key difference between acoustic and electric instruments in that, on the acoustic drum kit the volume is directly linked to how hard it is struck by the player. On electronic instruments the striking force (known as velocity) is independent of volume enabling these instruments to be played with force but turned down, and vice versa.
- 22 J. Lave and E. Wenger. *Situated Learning: Legitimate Peripheral Participation* (Cambridge: Cambridge University Press, 1991).
- 23 L. S. Vygotsky. *Mind in society: The development of higher psychological processes* (Cambridge: Harvard University Press 1978), p. 86.
- 24 Garrison and Anderson, *E-Learning In the 21st Century: A Framework for Research and Practice*.
- 25 See, for example, A. Jimbo. *Fujiyama: Combining Acoustic and Electronic Drums* (New York: Carl Fischer, 2003); B. Terry. *The Beginners Guide to Electronic Drums* (Milwaukee: Hal Leonard Corporation, 2011).
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