<center>**5**</center>

The iPad Orchestra ensemble: Creative and collaborative learning

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Introduction

This chapter explores self-directed creative and collaborative discovery as a mode of engaging the digital native (Prensky 2001) in new and effective learning experiences. This approach arises in response to the emerging landscape of electronic music practices surrounding wireless tablet devices and their associated software 'ecosystems' (Messerschmitt and Szyperski 2003). Some technologists teaching today immigrated early to the digital world and as a result face challenges in assimilating their learning experiences with those of their students. Embracing the less structured and rapidly evolving world of low cost computing devices and even lower-cost software instruments requires rethinking the essential skills needed by the contemporary musician to support their ongoing evaluation and creative use of such resources. This chapter considers student feedback from an initial experiment in self-directed creative and collaborative discovery using iPads as a mode of engaging music students in group electronic music-making practices. It examines the metalearning (Biggs 1985) strategies adopted by the digital native and in doing so assesses the necessary re-adjustment of pedagogical assumptions required, and resources available, for successful results in this new and evolving context.

Background

Assessment Design

The student feedback examined in this study was collected in a second-year ensemble performance subject where students were offered a range of repertoire to suit the instrumental skills of the group. Through a process of negotiation with their peers and tutors, small ensembles ranging from 2 to 10 performers were formed to undertake rehearsal and performance of the selected repertoire over a 13-week period. One contrasting option offered to students was to develop, as a group, an entirely new piece employing the musical resources of an Apple iPad. This approach was encouraged by a university-wide project that saw the distribution of iPads to all commencing students in an effort to update the teaching and learning practices of students and academics.

While the iPad offers a great range of tools for learning aspects of music and for music production, an exploratory and experimental approach was taken in this project, to allow students themselves to discover how best to exploit the musical affordances of the iPad. This approach represents a radical departure from the task of interpretation of existing notated and recorded repertoire usually undertaken

in the subject and it is the purpose of this chapter to try and unpick the implications and various factors at play in this move. We start by considering the position of the iPad in the current state of hardware and software technology and by considering the relationship of young student musicians to this technology.

Factors in the emerging landscape of software ecosystems

Messerschmitt and Szyperski (2003) introduce the metaphor of an "ecosystem" to describe the complex web of relationships involved in current software. These authors foresaw the unique nature of software as an entity discrete from either data or computing hardware. They understood both that "software becomes integral to the lifestyle of its users" (5) through the widespread adoption of mobile and ubiquitous computing technologies and the fact that software expresses, represents and in fact produces human organisational and social processes. Their prescient analysis imagined the context in which the emergence of the software market places such as Google Play, iTunes and the Apple App Store collapsed all media including books, magazines, music, film, TV and software applications into a small number of distribution outlets integrated within consumer's mobile devices. Following Messerschmitt and Szyperski's conception of an ecosystem, these virtual marketplaces served both the producers and consumers of software by providing a unified platform or environment to connect the desires of consumers and end-users with the ambitions of software designers.

What Messerschmitt and Szyperski did not forsee was the rapid decline of diversity subsequent to the introduction of Apple's iOS operating system in 2007 and Google's Android operating system in the same year. These software platforms enabled the success of the Apple iPhone, released in 2007, and the Open Handset Alliance Android phone devices starting in 2008, and the subsequent development of the Apple iPad in 2010 and various versions of the Android tablet devices in the same year. In the years following these developments, the term "software ecosystem" took on the new meaning of an exclusive choice between the two competing systems.

The hardware that developed in parallel with these software ecosystems, particularly the Apple iPad, offered a new level of convenience and affordances. These developments facilitated the transformation of music software to become an entertainment product in itself, thus reverting to an earlier model of music as a form of domestic entertainment in which ordinary people learned to "play" music rather than merely to listen to music. The widespread adoption of the iPad saw a rapid proliferation of music apps available through the Apple Apps Store, many incorporating the sophisticated features previously only available in expensive professional hardware and software. In fact, one of the key selling points of the iPad was the availability of Apple's *GarageBand* software on it, suggesting that the iPad could do for music production what the iPhone had done for photography. That is, make an artform ubiquitous, convenient and democratic and put professional results in the reach of ordinary hobbyist consumers.

One challenging question within this software ecosystem is how the user can discover new, interesting and useful music tools within the App Store through which all software must be acquired. Does this feature of the ecosystem tend towards diversity or does it limit the choices made by users? For the music educator, given the rich history of electronic music practice represented within some App Store offerings, we wonder what new approaches to ensemble music performance might this new ecosystem encourage and how might students learn through it.

How do young musicians encounter and adapt to new music technologies?

The concept of the "digital native" introduced by education researcher Marc Prensky (2001) suggests that there has been a generational change in expectations, responses and approaches to learning exhibited by current students and that this requires a change in thinking and approaches to teaching by those of the previous "digital immigrant" generation. For example, Prensky points to the attitude of the digital immigrant that reading a software manual might be a useful way to more fully understand its operation, compared to the expectation of a digital native that well-designed software will teach them how to use it by using it. Following Messerschmitt and Szyperski's analysis of software as both an expression or representation of social or technical processes, and as an understanding of the needs and wants of users (as modelled by the software designers), immigrant educators may question the potentially limited 'know-how' embedded in these designs as a constraint on the musical creativity of their students.

From a software ecosystem perspective, the iPad and available software become agents or actors (Latour 2007) in a network of pedagogical engagement that includes the institutional assessment context, the student's own musical and music technology background, plus the musical background of the software developers. We are interested to identify to what extent the processes engaged in during software selection, negotiation, rehearsal and performance preparation, linked into and reproduced the existing musical knowledge of the student participants or expanded and extended their knowledge and experience. We are also interested to see whether the increased autonomy and apparent control of the project enabled through handing over responsibility for repertoire generation and instrument selection had a positive impact on student attitudes towards their learning and music-making.

Autonomy, metalearning, expansion and reproduction.

Biggs (1985: 192) defines metalearning as "a subprocess of metacognition that refers specifically to learning and study processes in institutional settings, and more particularly to students' awareness of their motives, and control over their strategy, selection and deployment". Biggs found that an important factor in effective learning was a student's development of and recognition of an "internal locus of control" for their learning. His ideal or deep learner is "motivated to actualise an interest and develop

competence in particular academic subjects" (186) and they exhibit learning strategies that aim for meaningful learning, read widely, and inter-relate their learning with previous relevant knowledge. Metalearning requires an awareness, by the student, of the congruence between their motivation and learning strategy. A student's background and previous life experience will have a strong impact on their metalearning capacities and there remains debate over the extent to which metalearning can be taught.

In view of Prensky's assertion that software embeds an understanding of a given process (software embeds "know-how") and that digital natives have an expectation that software will teach them how to use it, a question arises regarding the "locus of control" in the creative learning endeavour. As Biggs (1985) has asserted this locus of control lying within the student themselves is a key factor in effective or deep learning. To what extent does the provision of seamless or transparent "know-how" within the software interface facilitate meaningful learning experiences that allow knowledge to be both scaffolded and expanded is an open question. There is a risk that software ecosystems both filter available knowledge and tend towards a "reproductive" approach to music making or an aspect of "utilising" rather than "internalising" (187).

Methodology

Three focus groups were conducted in 2014, 2015 and 2017 with 3-4 students in each group. Focus groups were held after the half-way performance assessment to peers. Focus group discussions lasted on average 40 minutes and were audio recorded and transcribed for later analysis. Pseudonyms have been assigned to the participants. The 2014 group included three male participants: Aaron, Don and Derek. The 2015 group comprised four males: Jude, Neil, Roy and Lex and the 2017 group consisted of two females and a male: Ruth, Nora and AJ.

Each group was asked about issues arising from their experience of developing an ensemble performance using iPads. A series of general open-ended questions asked participants about their objectives for the performance and their means of achieving these. Participants were asked to discuss their feelings and perceptions about the outcomes their group achieved; where they saw this experience leading them in the future; and asked to evaluate the strengths and weaknesses of the iPad as a musical instrument.

They were asked to evaluate the iPad and its associated software ecosystem as a platform for self-directed learning and asked to describe their methods of discovery for software tools and musical ideas. The questions shown in Table 5.1 emerged from the literature and previous teaching of the iPad Orkestra.

Question	Source of question
What were you trying to achieve with the iPad Orkestra this semester (both halves)?	Prior teaching experience of the iPad Orkestra ensemble; the subject's learning goals.
How did you go about making this happen?	Messerschmitt and Szyperski (2003): evaluating affordances of software/hardware ecosystems.
How do you feel about the outcome?	Messerschmitt and Szyperski (2003): evaluating affordances of software/hardware ecosystems and their ability to meet the desires of users.
What would you like to do next?	Messerschmitt and Szyperski (2003): evaluating affordances of software/hardware ecosystems and their ability to exceed existing user desire in order to fulfil a need for tools for professional practice.
What uses do you see for iPad Orkestra type music?	Prior teaching experience of the iPad Orkestra ensemble.
On the basis of your experience in this subject what are the strengths and weakness of the iPad as a musical instrument?	Messerschmitt and Szyperski (2003): evaluating affordances of software/hardware ecosystems; Biggs (1985: 190): evaluating impact of student's experience and background on their metalearning capacities; Prensky (2001) and Biggs (1985): evaluating transparent 'know-how' within the software interfaces and their impact on meaningful learning experiences; Biggs (1985: 187): evaluating software ecosystem use in terms of 'reproductive' or 'expanded' approaches related to 'utilising' rather than 'internalising' models of learning.
How well did the assessment tasks or the learning activities that are described in the learning guide match with the outcome you achieved? What constraints did the task description impose?	Biggs (1985: 191): evaluating "internal locus of control" as a factor in metalearning.
How is the iPad particularly useful for self-resourced, self-motivated learning?	Prensky (2001: 3): evaluating the iPad's capacity to "teach us to use it"; Biggs (1985: 192): assessing the iPad as a catalyst for deep learning and the student's metalearning through awareness of the congruence between motivation and strategy.
What sort of resources would you need to facilitate this type of learning?	Messerschmitt and Szyperski (2003): evaluating affordances of software ecosystem, software discovery processes and potential limitations of the iPad for music making and learning.
What other uses do you make of the iPad in your music-making?	Biggs (1985: 186): evaluating student's capacity to "inter-relate [learning] with previous relevant knowledge" and thus facilitate deep learning.
What learning uses do you see for iPads in any of the BMusic subjects?	Biggs (1985: 192): evaluating the "students' awareness of their motives, and control over their strategy selection and deployment".

Table 5.1: Interview Questions

The researchers discussed the expected outcomes and established a set of analysis codes based on the key themes identified in the literature. After an initial independent coding by the researchers a

comparison and discussion produced a new set of revised codes. These codes were subsequently reduced into two valence groups related to the central focus on knowledge and learning: enabling factors and expanded knowledge and learning on the one side; and inhibiting factors and reproductive knowledge and learning on the other. A further set of codes described the methods of discovery employed by the participants (see Diagram 5.1). The diagram indicates that participants' existing knowledge was implicated in both reproductive and expanded approaches. This parallels Biggs' (1985: 186) characterisation of surface and deep learning. In examples of deep learning, students reproduce what they already know and expand their knowledge by linking to new discoveries. Whereas in surface learning students do not move beyond the reproductive stage.
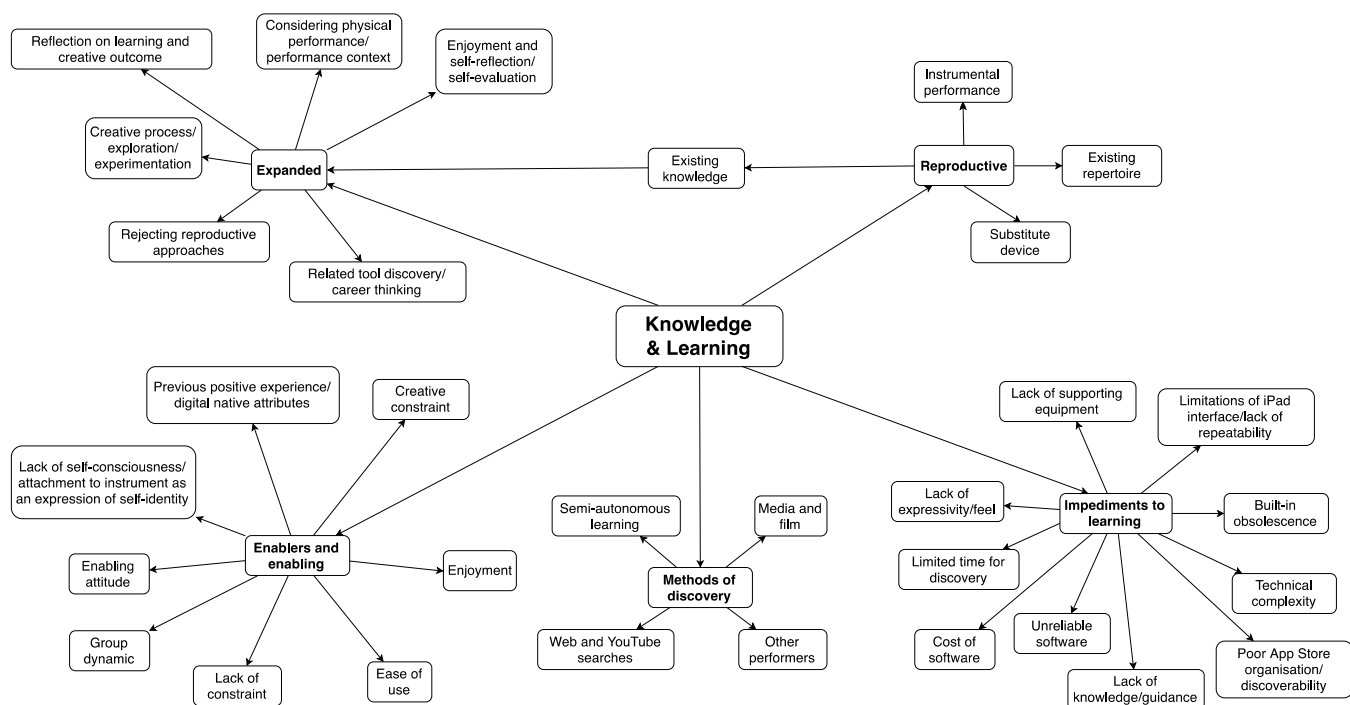
Figure 5.1: Interview analysis codes

Results: what the participants say

Enablers and enabling

Participants acknowledged that previous positive experiences with the iPad or their level of comfort with the technology enabled them to progress quickly with the creative task. Several of these participants identified as digital natives (Prensky 2001), Don (2014) reflecting that: "I think it worked well because we're all Gen Y … we're all tech-savvy".

The ease of use of the iPad for this group was both an enabler and a risk or a constraint to creativity or expression. Jude (2015) noted that: "It's ridiculously accessible…. If you have an iPad, you download

a free drum pad program. Get your friend to download a free piano program. And you can play something." However, issues around musicianship and musical values arise and "you can debate with someone musical … somebody [who] plays an instrument, [whether someone] who played [the iPad] could play it (the instrument) or not" (Jude, 2015). Ruth (2017) noted that with some *GarageBand* instruments "you were more like a conductor than like a player". The iPad enabled rapid experimentation: "you could quickly just pull something up and see how it goes, if it doesn't work, scrap it, move on to the next one." (Derek, 2014)

A positive enabling attitude was also identified as a factor. Participants were eager to discover new things and to find out "where can we go from here" (Don, 2014). The iPad was seen as a platform for creativity: "the only limit with the iPad is our own imagination" (Aaron, 2014), and as stimulating musical innovation "really trying to I guess push those boundaries … trying to think a little bit outside the box" (AJ, 2017). This attitude was often associated with a strong and positive group dynamic where "we were all very considerate of each other's feelings. We were never like 'that's a bad idea.' We always listen." (Ruth, 2017).

One factor that linked this personal attitude to group cohesion was a lack of attachment that might otherwise have characterised performance with traditional instruments. As Lex (2015) said, "we're always happy to give up ideas as well". The iPad was considered neutral in terms of instrumental and personal identity. Roy (2015) thought "it may have been different if there was an emotional attachment to what we're doing. Like ... 'this represents me'. It's more about let's get in and enjoy it. I think that helped."

Enjoyment was clearly an enabler in terms of the learning process with Nora (2017) noting "I'm enjoying ... the team that I'm in. I'm really … enjoying discovering new things and ideas and styles of playing." Aaron (2014) linked enjoyment to self-evaluation: "I thought it was good, I mean, like, you can see I'm enjoying myself a bit too much."

Neil (2015) found the lack of constraint in terms of the musical outcome helpful: "I think working it out is good. I think, one, you have to find it, which is always a good thing. Means you're doing the work. But, two, ... [it enables you to find] what suits you as a performer."

In contrast to this some constraints were helpful. The use and availability of time was crucial "for achieving things, yes. I could've ended up there with my VCS3 [synth app], finding wonderful sounds for ever and a day and then come to rehearsal, and 'oh, I've got nothing. I'm still playing around.' So, it's good to have boundaries" (Roy, 2015). Neil (2015) agreed "we were really limited with the time, so we had to pick something that we could actually achieve, something at the end of the short time." It is

noted below that this lack of time was also seen by some as an impediment to developing really creative responses to the task.

Expanded knowledge and learning

A determination to avoid merely reproducing existing skills or emulating conventional musical approaches enhanced learning and creativity. The term "iPad orchestra" used in the task description suggested this kind of reproductive approach to some students, which they rejected. Don (2014) "did a bit of research and mainly what I found was groups that just made [conventional] music together [with] their iPads or tablets. At first, I was thinking just … of [an] orchestra as in a classical orchestra type of thing. I thought, 'Oh, if we have to do something like that, it might not be something I want to do.' But I thought, 'Ah, you're widening the term into anything [performed by] a group.'" It wasn't only classical or orchestral music that was being rejected by participants. They rejected iPad arrangements of popular songs. Derek (2014) discovered iPad bands that "just played 'The Lion Sleeps Tonight', and I thought, 'Really? … Can't you do something a little bit more different than "The Lion Sleeps Tonight"?'". Derek saw the task as an opportunity to expand his musical practice: "if you're doing the more experimental stuff, it's more interesting because … it's not something you can make with an instrument."

Often the resources offered by a particular music app stimulated creative approaches. Starting from the work of a known artist was another fruitful approach to developing novel musical outcomes. Don's (2014) group had employed an app created by Icelandic artist Björk for an interactive album. He felt "That's something we could probably use … and … I showed the other two and we thought, 'Where can we go from there?'" Derek (2014) added: "I think we were definitely trying to experiment and make it as interesting as possible … we kind of built around this particular app … and, so we decided to kind of do a progressive thing, that's what we ended up doing, I think. Just kind of built off that app, really".

Taking musical inspiration from a known musical source was another approach. The theme music of the *Doctor Who* televisions series was the starting point for Roy (2015). "Originally, we had a score. But we felt that maybe that was … too limiting and … my own personal taste was reflected in the use of synthesizers. And so I thought, 'Why don't we make this more of a soundscape while keeping the *Doctor Who* theme in the piece.'" Jude expanded on the process: "We all researched [synthesizer] apps on the iPad that would be optimal for using … So, we had a range of apps that each of us brought in, which we then blended to make the sound work together." Derek (2014) linked the iPad to other technology. "I was very excited when I found out that you could plug it into *Pro Tools* and record it because then there are so many possibilities there."

These approaches indicate a process whereby participants provided their own scaffolding in their learning, building on their existing knowledge, leveraging techniques they already knew and resources

they discovered in the practices of other artists. This signals a movement from reproducing their existing knowledge, to reproducing the knowledge of others, finally to expanding, developing and originating their own musical ideas, resulting in a deep learning experience.

Useful generalizable discoveries were made in the context of experimentation. For example, Aaron (2014) reflected that he "did learn about the way I could expand around … different frequencies." Ruth (2017) felt that "Even though it's not training you in a theoretical sense … it's quite good for training the ears. I think it helps to identify 'Oh, that sounded really good, that worked together, those instruments blended' or 'they clashed'. It just starts building up that intuition that I think is an unspoken thing about musicians. It's (a) kind of important part".

Recognition of an internal locus of control and awareness of metalearning was apparent in the accounts of several participants. Neil's (2015) attitude towards receiving feedback reflects this. "Then someone comes in and says, 'This might need changing, because of this.' And then suddenly it's a new light on it, and it's a way that you can really tighten the performance". Jude (2015) noted that when he was offered feedback "I found it really easy to sort of not go, 'Oh no, we're doing something wrong' rather than, 'This is an opportunity to learn and say well let's approach this differently or include these ways of doing it'". Derek (2014) felt that the process "definitely forced us to look into it ourselves … after the first week or so, kind of based on the fact that we had to discover all this stuff ourselves. I did probably more research into it than I would have done otherwise … I think I put in a lot more effort than I would have otherwise. And I know … the way that I learn, I think that was a lot healthier for me, in particular".

Another factor in achieving a rich learning experience across all three year groups was pure enjoyment. This was often linked with positive self-evaluation. Reflecting while watching a performance video Aaron (2014) "thought it was good, I mean. Like, you can see I'm enjoying myself a bit too much … And it sounded all right in my opinion". Jude (2015) reflected "I think the outcome … was very different to what I had originally thought might happen. But it was still fun".

In the 2017 group, Nora noted "I'm enjoying, the team that I'm in I'm really enjoying discovering new things and ideas and styles of playing." For Ruth (2017), the iPad ensemble "kind of gives us as a group a chance to learn together. We would often do sounds and stuff and it would sound terrible and we would laugh about it, but because it's new to all of us, I think it gave us that kind of freedom where we weren't being self-conscious at all".

Some participants displayed "career thinking" indicating that these learners were looking beyond the immediate assessment requirements towards how their learning might be applied in the profession.

Aiming for a teaching career, Jude (2015) saw "… the use of iPads, as very useful in a classroom … to do a similar thing. Give them a number of weeks to get something together. Let them choose the apps that they need for it and perform in front of the class". Nora (2017), thinking about applications of the iPad in a music therapy career, had "had experience with adults with disabilities, trying to play the iPad, [now] knowing what's available is really good for developing those skills for those people that could not necessarily play a real instrument".

Speaking for her group, Ruth (2017) noted that "we all kind of come from contemporary music, so we thought if we did actual songs with some real instrumentation and we added in the iPads that could actually be something beneficial for us down the line in our careers".

Impediments to learning

Participants encountered several impediments to learning through the iPad. The app stores weren't always helpful because of the number of apps, its lack of organisation and the fact that many are "rip offs" (Don, 2014) of the best version. Some apps were too expensive. Lack of knowledge and guidance thwarted a "two man do-wop" (Derek, 2014) looping idea seen on Jimmy Fallon's show. Derek (2014) brought the idea to the group but "we never actually figured out how to do that". Love of a particular vintage synthesizer from the 1970s was a short-term impediment for Roy (2015) who ultimately found "it didn't add to what we were doing".

Unreliable software that "crashes every single time" (Derek, 2014) was an impediment. Students were aware of built-in obsolescence as a disincentive, understanding the need to keep up with new software and hardware "or you just get left behind and just die out" (Derek, 2014). One impediment to engagement could be other people's negative attitudes, with AJ (2017) noting they ask "what do you do in iPad orchestra? You press buttons?".

Lack of time was an impediment to learning. Exploring apps and creative ideas takes time, and within a 13 week semester, only so much time could be spent searching for apps. Roy (2015) "would've liked to have done more, well, just fully creative. Do something original of our own that grew from what you know each week. But I don't think we would've had the time to have done it under the constraints that we had". Another spoke of trying to screen share but finding, even after a Google search on how to create a network, no useful information emerging and thought "We'll leave that for later" (Derek, 2014). Replicating old synthesizers "so you could build sounds" (Jude, 2015) took more time than the semester allowed.

Because the iPad Orkestra was expected to perform twice a semester, and students were moving out of the conventions of instrumental performance, the physical aspects of performing with an iPad and the

performance environment was a major challenge. While participants wanted to "integrate it completely into the performance…like in theatre" (Jude, 2015), impediments were noted in achieving this goal. In particular the touch response of tapping glass has "a delay, [which] can throw things out a lot" (Lex, 2015), especially when four people are "trying to do the right thing" (Neil, 2015). Music stands were enabling for a rehearsal but viewed as an impediment to performing. If the aim was to perform standing up, thereby adding "a bit of showmanship [rather] than us sitting down" (Don, 2014), then the cables needed to be long enough, and preferably performing without the stands.

Connecting other devices to the iPad revealed some impediments to learning. Having only one mixer for the group introduced several problems. It "meant that we can really actually only have one finger on it [and this] limited us to what we could do" (Nora, 2017). Also, because the mixer "is a digital one, and we practiced with the old school ones … it limited us to what we could do" (Nora, 2017). Plugging a guitar into the iPad and using it as a pre-amp worked well "but the sound quality … [was]really bad. Sort of not worth it" (Aaron, 2014). The expressive facility of the iPad was brought into question, as "you can't get the human feel through the iPad" (Ruth, 2017), and for AJ (2017)" it's definitely not a real instrument, [more] a simulation". Yet for Nora (2017) it was an instrument of possibilities – "if you can imagine it then there's a good chance you can make it happen".

Derek (2014) acknowledged that the iPad was small and flexible, "but really, if you were a DJ, performing in a club or anything, and you were centre stage, you probably wouldn't get a nice, warm reception without all of your gear around you. If you just had an iPad there, and … your gear is all on your iPad, you just wouldn't … get the same sort of vibe". The importance of stage balance was also highlighted by their experience, Don (2014) noting he couldn't hear what he was doing "because you [two] had the low frequencies and I was doing what I do and I go, 'I can't actually hear what I'm syncing'".

However, the students imagined ways to enhance their stage presence in future performances - "One of the ideas that I had for our next performance, [if you could] find a way of getting the iPad to talk [wirelessly] to a mixer, I would have liked to have been able to walk around, and it would have been nice to have a bit of interaction" (Derek, 2014). Roy (2015) expanded on the theme of stage presence: "… you want the dramatic theatrical aspect of it. I think we really needed that … to get a connection with the people, that would've been really useful".

The semi-autonomous learning environment, while largely enabling, raised discussion of how leadership of the group occurred. It also saw some musical comparison with others with Roy (2015) saying "I think you guys are more musicians than I am [because you read music better than I do, and] I would've liked to have done more, well, just [be] fully creative". When asked about conflict within the

group, Nora (2017) noted "you wanted to play a song from the start … you were itching to play a real song", indicating different ways of working, with the response from AJ (2017)," I'm still itching to play a real song … to play a real instrument".

Reproductive knowledge and learning

As noted above certain approaches to using the iPad such as reproducing exiting repertoire were rejected as not leading to new knowledge or valuable creative outcomes. Approaches such as plugging an instrument into the iPad were explored for "possibilities with guitar pedals and effects and stuff like that" (Aaron, 2014) but were not pursued as using the iPad as a substitute device was not regarded as musically interesting. Using the iPad as "a conventional instrument that you could actually perform music that people already know" (Aaron, 2014) did not lead to useful results.

However, utilising existing knowledge was often a stepping stone to more expansive approaches or a pragmatic fall-back that resulted in more satisfactory outcomes.

Building on existing knowledge

Students showed an awareness of integrating knowledge they have already trialled and used. Considering known musical styles sometimes lead to expanded thinking. Derek (2014) considered "recreating computer game music … the kind of iconic themes like *Super Mario*" but while suggesting this, still looked ahead to perhaps creating "a mash-up of a couple of those" which would be a different outcome to creating a copy of a game theme. Seeing a documentary on how Björk makes music and had created an app for the iPad, led one participant to find the app *Solstice*, and this took him from *Garage Band* into a new sound world. Lex (2015) told how he'd used an iPad for his secondary school final year music composition submission, using a DJ app, drawing in astronomy sounds from a website, plus live vocal ensemble, but with *Garage Band* "in the background just sitting there waiting". Ruth (2017) used *Garage Band*, iPad's default music app, as a basic tool, in one case "predominately to get the ideas down so I don't forget them" using the recording function. All of these students were building on previous positive experiences which enabled further expanded exploration and creativity.

Extending reproductive thinking from the known to experimentation was seen when participants spoke of how they do, or could, connect the iPad to other devices. Connecting the iPad through Bluetooth with other things to "I guess, experiment that way and see what we can control" (Neil, 2015) was one possibility.

Performing with iPads as a "touring band [that] … if you did it really well … could go pretty far [when group members find] a central theme to our music and in the way that we create it" (Don, 2014). Here,

the concept of a touring band is drawn into the iPad music-making community, especially when the group members share common musical thinking.

Reproductive knowledge was used as a fall-back when something too complex was encountered during the creative process. One software app, *Table Top*, "looked too complicated to me, so I didn't use it … I found using a keyboard app was easy for me … I could create different sounds, but still use the keyboard" (Neil, 2015). Here Neil, a keyboard player, preferred a topography he knew yet was prepared to explore new sound worlds, the reproductive facilitating expanded sound thinking.

Methods of discovery

Within this project student participants were given very little in the way of learning resources. Therefore, it is interesting to observe how the participants went about resourcing their own learning.

The process of exploring sound and creating musical outcomes on an iPad is "very similar to preparing for an essay … looking at how others have made it work, finding material that's going to work and then the rest of the time … putting it into action" (Ruth, 2017). Ruth acknowledged this research needed to be undertaken before the creative work could commence. So where did the information come from? Don (2014) used "YouTube searches and Google searches about apps that can create music". He also "saw a documentary on ABC [TV], about Björk and how she makes music" from an app that she developed. Participants learned from their peers. Derek (2014) had seen a friend "… use one of the iPads as kind of a second screen for … *Pro Tools*". The online learning resource *Lynda.com* to which students have institutional access proved useful. Don (2014) noted that "I've liked using Lynda, I've been doing my own little bit of extra learning and looking through audio videos." In contrast, Derek (2014) stated that he had "looked on Lynda.com as well for iPad music, and they mainly had [technical instruction], I thought, 'That's not what I need to know.' … It's more creative stuff that I was looking for then".

Describing how YouTube videos could be useful, Ruth (2017) explained that "we would generally try and find artists that are using the iPad in … a similar way. We found a really interesting video by [New Zealand artist] Kimbra.... It was just her on her iPad … we found that really interesting … but … it's sometimes hard to know exactly [what Apps were used]".

The Apple App Store proved frustrating. Ruth (2017) described her experience: "So, we download quite a few [apps]. Some of them work and some of them don't. But, it's really trial and error. Some of them are hopeless and then some of them are great".

Discussion

The creative and collaborative learning that took place with the iPad Orkestra revealed several pathways. We have characterised these learning processes as either expanded or reproductive. Knowledge and learning could be expanded in the creative process through exploration and experimentation, through related tool discovery, the rejection of reproductive approaches, consideration of physical performance and the performance context, reflection on the creative learning and creative outcome, and through enjoyment, self-reflection and self-evaluation. Reproductive processes were not always a negative force. Existing knowledge was often a trigger or platform for launching into new software, new hardware combinations and new sound exploration. The university subject housing the iPad Orkestra required a performative outcome and this saw discussion of known performance modes move to thinking about and trialling new ways of performing with iPads. Challenges that required more time than the semester allowed saw a fall-back to reproductive thinking taking place to move the process along.

Guiding this learning were several factors that affected the process and outcome. Impediments to learning could be lack of time, lack of support and guidance, lack of supporting equipment, limitations of the iPad interface including its lack of expressivity and feel, the cost of software, the amount of software and poor App Store organisation that made discovery difficult, and at times the unreliability of software. Built-in obsolescence was in the back of participants' minds and at times, technical complexity required a different path. Enabling factors were more focused on the group members themselves and included the group dynamic, an enabling attitude, previous positive experiences of the digital natives, a lack of self-consciousness and a sense of connection to the instrument as an expression of self-identity, plus enjoyment, that all drove the exploration onwards. Similarly, ease of use and the balance between creative constraint and lack of constraint encouraged a satisfying creative outcome.

From the experience of creating with iPads, several methods of discovery were noted. Knowledge was drawn from friends, media and film, other performers, the semi-autonomous group learning environment, and web and YouTube searches.

Lessons for educators and digital immigrants

A typical pedagogical approach in the tradition of electronic and computer music training might start from the principles of sound synthesis and progress through elements of composition and performance with electronic music systems. Or, as has been seen in examples of group learning in laptop orchestras over the last decade (Trueman, et al 2006; Wang, et al 2008), provide a pre-designed framework including a scored composition or at the least a palette of sonic resources and a unified control system on which to develop a performance. In contrast, the approach taken through the iPad Orkestra relies on student-directed collaborative learning, on a student's own capacity to resource and explore a path to

new musical discovery, and to collaborate with others. The hardware and software ecosystems offered by the iPad and other tablet computing devices contrast with the conventions of scored ensemble instrumental performance in which this project was embedded. Within this field of emerging musical practices, real opportunities for metalearning (Biggs, 1985) present themselves. In the research presented here, student musicians have shown themselves to be capable of transforming this assessable creative and collaboration context into opportunities for discovery and deep learning.

References

Biggs, J. B. (1985). The role of metalearning in study process. *British Journal of Educational Psychology*, 55, 185-212.

Latour, B. (2007). *Reassembling the social: An introduction to actor-network-theory*. Oxford: Oxford University Press.

Messerschmitt, D. G. and Szyperski, C. (2003). *Software ecosystem: Understanding an indispensable technology and industry.* Cambridge, MA, USA: MIT Press.

Prensky, M. (October 2001). Digital natives, digital immigrants. *On the Horizon*. 9 (5), 1–6.

Trueman, D., Cook, P., Smallwood, S. and Wang, G. (2006). PLOrk: The Princeton Laptop Orchestra. Paper presented at the *International Computer Music Conference* 2006, New Orleans.

Wang, G., Trueman, D., Smallwood, S. and Cook, P. R. (2008). The Laptop Orchestra as Classroom. *Computer Music Journal*, 32 (1), 26-37.