Teaching Musical Instruments Online: A selective literature review

Dr Jonathan Savage,
Managing Director, UCan Play

Supported using public funding by ARTS COUNCIL ENGLAND

Introduction

This short paper explores some of the recent research concerning the teaching of musical instruments online. Starting from a brief summary of research carried out by NYMAZ and its research partners, it presents research that explores asynchronous and synchronous online learning environments in music education through a chronological presentation of some of the major studies from the last ten years. Following this, it considers issues of online digital audio latency and how these are impacting on music education online.

Online Learning Environments and Music Education

Following on from a specific recommendation (no. 33) made by Darren Henley in his 2011 *Review of Music Education in England* (DfE 2011) that future research should examine how technology could enable better teaching of music (particularly in rural communities), the Connect: Resound project led by NYMAZ has trialled alternative approaches to the delivery of instrumental music teaching to children in rural areas.

Working collaboratively with the University of Hull and UCan Play, the project explored the following research question:

> Can internet technologies increase the ability of Music Education Hubs operating in rural areas to deliver a comprehensive, high-quality, yet affordable music education offer to all children and young people? (NYMAZ 2015, p.5)

The project delivered the three key activities (providing instrumental music lessons online, sharing live performances with primary schools, and a programme of continuing professional development for staff) through the adoption of a set of standard technologies including a Roland VR3-EX video and audio mixer and streamer, sets of microphones and a basic Skype communication platform. Seven primary schools were identified as research partners and the key research activities took place during November 2014 to May 2015. Between 2015 and 2017 the project has worked across England with several other rurally based Music Education Hubs, implementing the approach that was the subject of the action research in North Yorkshire. The key findings of the research are presented in a full report published by NYMAZ in 2015 (NYMAZ 2015).

The Connect: Resound pilot project received a positive response from teachers, students, parents and headteachers. Teachers reported that students had made good progress and parents agreed; 74% of students were keen to continue with their lessons. Although teachers expressed the view that the online delivery model was different from face-to-face

teaching, they reported significant benefits in terms of the time and costs saved in travelling to remote communities. Despite the cost of the equipment used in this research project, the potential savings associated with this approach are significant and the research reported that it would definitely be a cost-effective option for music services to consider. There are broader benefits too, e.g. being able to provide teaching of less popular musical instruments to individual or smaller groups of students in a cost-effective manner.

The Connect: Resound project is a good example of a synchronous online learning environment (SOLE) in which students and teachers interact in a live teaching environment online. However, SOLE are not the norm in music education; asynchronous online learning environments (AOLE) in music education are more common. AOLEs have been characterised as 'student-centred', allowing individual students to work through prepared materials at their own pace, utilising a broad range of online materials such as discussion forums, video content, wikis or blogs to help inform their learning. One of the most established AOLE music programs is Berklee Online (https://online.berklee.edu), which offers courses in a huge range of musical topics including music production, songwriting, orchestration and a large number of musical instruments too. Despite their prevalence, there have been few significant studies that have explored the benefits or limitations of such an approach to teaching and learning in music education.

In contrast, SOLE model themselves on traditional learning environments such as classrooms and, of course, require the student to be physically present at specific times to receive their music lesson. As we have explored in the earlier NYMAZ work, there are a broad array of environments that can be used for these lessons, including WebEx, Blackboard, Google Hangouts and less formal communication tools such as FaceTime or Skype. Within the literature reviews considered in writing this paper, there is a consensus that the research data indicates that students view synchronous interactions positively, as Watts writes:

> ...because of instantaneous feedback, being able to see their classmates, and because they report feeling more engaged in the online experience (Falloon 2011, Hranstinski 2008, Stein et al., 2009, Strang 2013). ...Participants offered insight that the synchronous interactions felt more like talking, and students engaged more with their peers. In addition to improved social interactions with their peers, students also reported an advantage of synchronous interactions was the ability to monitor classmates' reactions during discussions, which led to psychological arousal (motivation) to continue engaging with their peers (Watts 2016, pp.27-28).

In SOLE with multiple sites, the teacher has to manage voice or other audio forms of communication in a highly proactive way. Historically, these elements have not been simultaneous. Rather, online tools such as virtual 'hand raises' or 'thumbs up, thumbs down' allow the teacher to monitor learning in multiple sites, move between them online and intervene as appropriate. However, pace is often raised as a concern in the literature within these environments, e.g. Finney 2017, p.53 (and see below). This might be a particularly important consideration for our work with primary school students in a 'one-to-many' model of instrumental teaching.

Writing from her experiences of the Australian music education system, Lancaster's paper (2007) is one of the earliest studies of online instrumental teaching and learning. It explores the development of online instrumental teaching with a focus on string teaching, notably the violin. Leaving the technical elements of these systems aside (given that many of the concerns she raised in 2007 have not been addressed by recent technological advances), she raises a number of pedagogical elements that teachers were commonly concerned with.

Firstly, eye contact is discussed as a key principle in reducing a student's feeling of isolation. Lancaster notes the importance of positioning a screen or computer monitor in such a position that it facilitates the interaction between teacher and student and which helps build a positive relationship (Lancaster 2007, p.14).

Secondly, she explores, at some length, the affordances of single cameras (e.g. pan and zoom) and how these functions can help provide a broader array of images that are conducive to a student's understanding of a particular technical element and the teacher's corresponding need to assess what progress has been made. Many of the studies that she refers to used single cameras but did allow remote control of the camera at the student's location by the teacher. Multiple cameras were not explored in this study but the affordances that a multi-camera system offers can only be seen to be advantageous in addressing her concerns here (Lancaster 2007, pp.14-15).

The Connect: Resound report shows that the standard definition cameras provided an adequate image for most teachers and the multiple images (three) provided by the Roland VR3-EX was seen as a positive benefit from the teachers' perspective. Teachers reported that students concentrated well during sessions. They were able to integrate the use of different camera angles into their teaching during the course of the project and, by the end of the project, teachers were using these different viewpoints for similar proportions of the delivery time.

In respect of digital audio, Lancaster's study also makes the case for high quality audio as an essential element of the technological environment for these lessons. High resolution audio captured by high quality microphones allows teachers to hear the intricacies of articulation, tuning and tone in a helpful way.

In the Connect: Resound project, the sound quality was considered 'good' or 'very good' by the majority of participants, although ambient noise (from adjacent areas in the primary school) and poor acoustic control (e.g. the reflection of sound in larger rooms) were cited as negative factors. The main challenge for teachers was the inherent time delay associated with using Skype. The reasons behind this and more recent research that has sought to minimise online digital audio latency will be considered in more detail later in this literature review.

Lancaster also notes the problems associated with delay within synchronous learning environments but reports that teachers and students in the projects she observed soon overcame these problems, found work arounds and were rarely bothered by it 'after the first few minutes' (citing Tait & Bliklock 2005, p.4).

As we have found in our work, a blended model of face-to-face instruction and synchronous online learning was found to be the best approach in Lancaster's study. She goes as far as saying that 'neither mode should be exchanged for the other: videoconferencing enhances traditional instruction' (Lancaster 2007, p.16). This is a bold statement and an interesting way of considering what might be the best model of delivery for instrumental teaching. Towards the end of her paper, she considers the wider range of benefits that an online model of instrumental teaching can afford, situating the broader benefits of access and inclusion alongside development of new artforms and educational opportunities for teachers and studies alike. In the ten years following on from Lancaster's paper, it seems fair enough to comment that many of these opportunities have materialised and are evidenced in the broad array of online musical activities that one can find today. However, it also seems fair to comment that many music educational institutions are still struggling to adapt to this pace of change (with some notable exceptions).

Another early and well cited study of a SOLE model in music education was written by Richard Dammers (2009). This study followed his experiences of teaching the trumpet to a student via Skype over a nine-week period. Dammers found that the progress made by the student was broadly similar to that made within face-to-face lessons. His ability to assess the student's progress was not compromised and the pace of the lessons was good. Dammers encountered the familiar problem of

delay but, as the study moved on, both himself and the student adjusted to this to the point of becoming unaware of the problem. However, the curriculum experience being offered was limited by the inability to play duets together, and both the teacher and student reported the environment as being a little more impersonal due to the lack of a physical presence in the same room. Dammers also reports limitations in terms of movement and difficulty in appreciating the different dynamic levels within the musical performances given by the student (headphones were used throughout the study).

Dammers' study concludes with some broader points about the positive affordances of a SOLE as opposed to an AOLE given the nature of musical performance itself (i.e. it is something that exists, by its nature, in real time with musicians working together) (Dammers 2009, p.24). In my view, it is important not to forget this important point. Despite the difficulties of latency, playing music together is something that is integral to an approach to music education that seeks to 'teach music musically' (Swanwick 1999).

Following on from Dammers, another early study by Orman and Whitaker (2010) compared time usage during face-to-face and synchronous online instrumental lessons featuring the work of two students learning the tuba (in Years 7 and 8). Neither of them had taken lessons on their instruments beforehand and they had no experience of online teaching. Both of the teachers had over fifteen years' experience of face-to-face teaching. The findings of the study revealed that teacher modelling and off-task behaviour occurred significantly more often during face-to-face lessons. On the other hand, student performance and eye contact increased during distance lessons.

Brändström et al (2012) drew inspiration from the Dammers' study too and explored the issues associated with online instrumental teaching and learning through two cases in Sweden that involved the teaching of electric guitar. The researchers were particularly keen to investigate the differences between an online approach and a face-to-face approach. The overall finding from the study was that teachers and students seemed to consider that online teaching was a positive experience and saw it as a fruitful complement to face-to-face teaching. As we have found, the most difficult part of the online teaching was playing together or marking the rhythm together concurrently. The results suggested that from the teacher's perspective, videoconference teaching is more intensive than face-to-face teaching and requires both thorough planning and readiness to improvise during the lesson. These are key lessons for our teachers. Teaching online is not the same as teaching face-to-face. The research seems to be indicating that it is more demanding

(for various reasons) although there is an expectation that this demand will lessen with the experience of managing the online environment and teaching within it.

Moving to the last couple of years of reported research, Finney's doctoral thesis (2017) notes that there are limited studies on the differences between synchronous and asynchronous online music instruction, and that music education generally is relatively behind methods used in other disciplinary areas. His study examined the learning that could be facilitated in a distance-based, synchronous, online approach to the teaching of guitar in a class setting within two schools simultaneously via the WebEx platform. His key research questions were:

> 1. What are unique characteristics about this hybrid-learning environment that lead consequentially to participant feelings and learning outcomes?
>
> 2. What instructional elements were gained and/or lost within the design of this hybrid learning environment model?
>
> 3. Was this hybrid-learning environment effective in teaching basic beginning level guitarists how to play the instrument? (Finney 2017, p.4)

These questions were explored through a process of video analysis and grounded theory. Whilst this was a small-scale study, the findings are interesting for our work. Firstly, Finney emphasises the importance of teaching assistants in the remote schools. Simple processes such as seating plans, the appropriate placement of cameras to ensure good coverage of the classroom and wired connections to networks rather than a reliance on WiFi are all discussed (Finney 2017, p.53).

Like the Dammers' study (2009), problems of connection and delay were encountered and these did impact on the pace of the teaching that Finney could facilitate. Dammers' work was focused on one-to-one tuition; Finney explored a 'one-to-many' approach (i.e. himself and two primary schools) and therein were some specific difficulties. Using WebEx, he was able to juggle audio feeds to stop 'cross-bleeding' of microphones through muting them at specific points to ensure that students could hear him clearly. Finney emphasises that the teacher is also undertaking a significant management and moderating role in terms of the web environment. This can be time consuming at first until the affordances of the web conferencing environment are fully understood and the operating principles become more fluent within the teacher's skillset (Finney 2017, p.54).

Finney also comments that the strong visual models employed within the synchronous delivery model were a benefit for students and teachers

alike. The provision of video materials, webcams, screen-sharing and interactions between classrooms and between individual classrooms and himself as the teacher, all produce a rich visual environment which, he argues, 'greatly improves the student's overall learning experience' (Finney 2017, p.55).

Dye's study (2016) documented the behaviour of music teachers and six middle school-aged students in online lessons with instructional delivery facilitated through desktop videoconferencing. The 25 separate lessons were recorded, transcribed, and analysed for emerging behavioural patterns of both students and teachers.

Notable results from Dye's study indicated that teachers chose to use questioning more and modelling less, while students demonstrated less and used verbal responses more when compared to traditional face-to-face lessons. This is a warning for our work. If the opportunities for performance-based activities are seen to be difficult in the online medium, and verbal exchanges dominate rather than musical ones, then the processes of teaching music musically could be compromised.

Positive elements in Dye's study included a high degree of focus and minimal time off-task by both teachers and students. Concurring with prior research, teachers guided the course of lesson activity and their teaching was dominated by verbal activity.

In the conclusion of Dye's paper, he writes:

> This study resulted in a mix of promise and disappointment regarding the use of videoconferencing as a viable means of conducting applied music lessons online. This exploratory study used a minimally adequate Internet connection and it is believed that any consistent enhancement in the available bandwidth and transmission of data speeds would have served to enhance the lesson experiences of all participants. It would appear that desk-top videoconferencing does offer a nominally acceptable, substitute music lesson opportunity. The quality of the audio and visual interaction is central to the achievement of instructional success. When appropriate preparation, design, and facilitation are used in conjunction with adequate technology, reasonably successful online music instruction and learning can occur. (Dye 2016, p.169)

The importance of these comments to our work is vital. High quality equipment and a good, consistent and fast broadband connection are the platform upon which successful online instrumental teaching can be built.

In addition to the equipment considerations, during the Connect: Resound research a number of environmental issues arose that are worth noting. Firstly, establishing a suitable space for teaching is desirable. Rooms in rural schools have multiple functions and the needs of the online teaching and learning experience need consideration. The size of the room is important to take account of; smaller rooms can limit the camera angles and larger rooms can present acoustic challenges. Finally, the location of a room that limits the amount of sound spillage from nearby classrooms is also worth considering.

Dye's paper concludes with an interesting final assertion that argues for the supremacy of face-to-face musical instruction:

> The strongest concern is reserved for the use of any online lesson as a replacement for traditional instruction. Music is communicated in a unique and personal manner when it is experienced live as evident when comparing a live performance experience to a recording. It stands to reason that beyond the negative issues of reliability and clarity, there often is an inherent quality to live musical communication that cannot be broadcast or reproduced. As recorded music over the past 100 years has not eliminated the desire of humans to experience live musical performance, it might be speculated that videoconferencing should not eliminate the necessity and preference for live face-to-face instruction. (Dye 2016, p.169).

Anecdotally, I think that this is probably quite a commonly held view amongst music teachers. However, perhaps the very assertions on which this claim rest need to be considered a little more carefully within our contemporary experience of accessing music more broadly through live events and streamed technologies.

The benefits reaped from the co-evolution of streamed and live music have been reported in the literature. Whilst the digitisation of music through streaming services has gained in popularity in recent years, the loss of income associated with the revenues of the recorded music industry were initially seen to be a cause of concern. However, the resurgence of the live music industry and the parallel paths of increasing popularity of streaming services have been reported to be working in a co-evolutionary way. Drawing on data collected over three decades within the USA, Naveed, Watanabea & Neittaanmäkia (2017) write the interplay between these two sectors has resulted in a new form of 'live-concert-streaming music industry'.

This is pertinent because there are those that might worry that streamed or online instrumental lessons would be a threat to face-to-face provision. It is important to argue that perhaps these alternative approaches could become co-evolutionary in the same way as the relationship between live and streamed music practices have developed in recent years. One has not replaced the other. As Naveed, Watanabea and Neittaanmäkia's research indicates, both have benefited and we can hypothesise that the same might be true in respect of delivery models for instrumental teaching.

Returning for a moment to our opening theme of asynchronous and synchronous environments for online learning, there is a wealth of research literature of a more general type that seeks to identify the benefits and limitations of each, and provide comparisons between the two. Watts provides a very comprehensive review of the literature in her 2016 paper (Watts 2016). Her closing remarks echo the importance of teachers making wise choices about the tools that they choose to use in educating their students. However, the evidence, she suggests in the outcome of her review, is clear. Students themselves feel more connected to the online experience, report higher levels of satisfaction, continue to be motivated to engage, and are more successful in group and individual work when they engage online. As teachers and designers of a space within which instrumental music lessons will be delivered, we need to continue to consider the motivations and needs of our students, the specific demands of the content we are seeking to deliver, and the available technical support requirements. If we can maintain this broad perspective then the chances of us promoting a high-quality music education online are significantly improved (Watts 2016, p.31).

Digital Audio Online and the Implications for Music Education

Marins' paper to the 23rd International Conference on Auditory Display (Marins 2017) presents a useful summary of the state of play regarding the use of digital audio in online music education. Within the paper, some of the limitations of digital audio online are presented. The frequency range of a typical web-conferencing software like Skype, for example, is between 80 to 80,000 Hz (compared to the frequency range of human hearing which is between 20 – 20,000 Hz). There are also various processes of compression that take place within software that is designed principally for vocal communication. What are the consequences for instrumental teaching online? The suggestion is that some of the subtleties of the artistic and aesthetic elements of a performance might be lost.

But Marins quickly highlights the principal issue that we have grappled with over the years – digital audio latency. He agrees that the latencies associated with real-time video on the Internet makes real-time performance between two musicians via a video chat link all but impossible.

> Another common issue in synchronous communication is the so-called latency. This occurs due to the fact that there is a number of data conversion steps involved in the audio stream process (the analog sound is captured by the microphone, converted to digital and then converted into a format that can be transmitted), and in each conversion step can generate a delay effect or the so-called encoding latency. Obviously that latency can interfere in the perception of the sound produced by an instrument of a student. (Marins 2017, p.235)

In layman's terms, when a student plays along with a teacher the following steps happen, with each step introducing a little additional delay:

- The teachers' sound is picked up by a microphone and converted into a digital audio signal;
- The digital audio signal is converted to a compressed format for streaming;
- The compressed audio signal is mixed with the video signal for transmission;
- The audio/video stream is sent over the Internet;
- The stream is decoded by the student's computer;
- The digital audio signal is converted to an analog signal and played through the student's speakers/headphones.

In addition to this, when the student plays along the same steps need to happen in the other direction, effectively doubling the delay before the teacher hears them. Internet connection speed is a primary factor in the total delay time, but the other steps contribute significantly.

Solutions to this are complex and expensive. Marins cites one approach developed by the Conservatorio di Musica Giuseppi Tartini in Italy. Their free software (called Low Latency or LOLA for short) has been developed and tested in a range of online environments that featured simultaneous musical performances and distance learning. The researchers also undertook a comparative study with other videoconferencing platforms such as Skype. Marins reports:

> The results indicated that LOLA seems to be more efficient than Skype and Polycom in terms of online music making, teaching and learning. However, they state that – although the software is free – LOLA requires specific equipment with estimated costs of $5.386 which can prevent some schools, universities and professionals from using the preferred software.

Further information about the LOLA software and the accompanying hardware requirements can be found here: https://lola.conts.it

Another interesting project that explored how musicians can participate online together in 'real' time was the Online Orchestra, an Arts Humanities Research Council funded project at Falmouth University. According to their website, the project sought:

> … how we can use the internet to give children and amateur musicians who live in remote communities around the country the same opportunities to play in an orchestra as those who live in larger towns and cities. We're designing an online orchestra that will allow people who live hundreds of miles apart to make music together for the first time. (Falmouth University 2017)

It is important to note that the Online Orchestra did not set out to meet, and nor did it solve, the issues associated with online digital audio latency that we have summarised here. In the findings of the project, they state clearly that:

> … it is not possible to reduce latency below the threshold of perceptibility when using the types of network connection and computing equipment currently available in remote locations around the UK (Research Councils UK, 2017).

Their solution to this currently intractable problem was to compose the music in such a way that allowed for a creative handling

of latency in such a way that sought to overcome the physical separation of musicians:

> Composers on the project team wrote music designed explicitly for latency-rich environments, such that the latency is built into their scores. Their music works in tandem with software designed by the Online Orchestra technical team that controls network latency and synchronises it to the requirements of the musical score. (ibid)

Anyone watching the resulting performance given by the orchestra on the 12th July 2015 (https://vimeo.com/119666191) will note the huge bank of computers and technicians that were required to even facilitate this approach to the delivery of an online live musical performance with musicians in remote and physically-isolated locations.

We are not suggesting that these approaches would be a sensible way forward for the Connect: Resound project per se. Rather, finding creative work arounds to the problems associated with online digital audio latency with the use of backing tracks or other pre-prepared teaching materials are likely to be far more productive. Like the Online Orchestra, we need to devise new, and perhaps adapt, pedagogical approaches in light of this issue rather than seek to overcome it. Using specialised software and an extremely high speed internet connection can mitigate the issue of latency somewhat, but the problem cannot be entirely avoided.

Dr Jonathan Savage
Managing Director
UCan Play
20th October 2017

References

Brändström, S., Wiklund, C. & Lundström, E. (2012). 'Developing distance music education in Arctic Scandinavia: electric guitar teaching and master classes'. *Music Education Research*, 14 (4), 448-456.

Dammers, R. (2009). Utilizing Internet-based video conferencing for instrumental music lessons'. *Applications of Research in Music*, 28, 17-24.

Department for Education (2011). 'Music Education in England'. London, DfE. Also available from goo.gl/euvYjG [last accessed 20th November 2017].

Dye, K. (2016). 'Student and Instructor Behaviours in Online Music Lessons: An exploratory study'. *International Journal of Music Education*, 34 (2), 161-170.

Falloon, G. (2011). 'Making the Connection: Moore's theory of transactional distance and its relevance to the use of a virtual classroom in postgraduate online teacher education'. *Journal of Research and Technology in Education*, 43 (3), 187-209.

Falmouth University (2017). 'Online Orchestra'. https://www.falmouth.ac.uk/online-orchestra [last accessed 28th November 2017].

Finney, L. M. (2017). 'Reinventing the Roster: A study of two rural elementary schools participating in a hybrid online learning environment for class guitar'. Submitted to the faculty of the Jacobs School of Music in partial fulfilment of the requirements for the degree, Doctor of Music, Indiana University. Also available from https://scholarworks.iu.edu/dspace/handle/2022/21331?show=full [last accessed 20/10/17].

Hranstinski, S. (2008). 'A Study of Asynchronous and Synchronous E-Learning Methods Discovered That Support Different Purposes'. *Educause Quarterly*, 4, 51-55.

Lancaster, H. (2007). 'Music From Another Room: Real-time delivery of instrumental teaching'. In *NACTMUS National Conference, Queensland Conservatorium of Music, Brisbane, 29th June – 1st July 2007*.

Marins, P. (2017). 'Challenges and Constraints of Using Audio in Online Music Education'. The 23rd International Conference on Auditory Display (ICAD 2017), June 20-23 2017, Pennsylvania State University.

Naveed, K., Watanabea, C. & Neittaanmäkia, P. (2017). 'Co-evolution between streaming and live music leads a way to the sustainable growth of music industry – Lessons from the US experiences'. *Technology in Society*, 50, 1-19.

NYMAZ (2015) 'Connect: Resound Research and Development Report'. http://www.nymaz.org.uk/connectresound/download-resources [last accessed 30th September 2017].

Orman, E., & Whitaker, J. A. (2010). 'Time Usage During Face-to-Face and Synchronous Distance Lessons'. *American Journal of Distance Education*, 24 (2), 92-103.

Research Councils UK (2017). 'The Online Orchestra: Connecting remote communities through music'. http://gtr.rcuk.ac.uk/projects?ref=AH%2FM001482%2F1 [last accessed 27th November 2017].

Stein, D. S., Wanstreet, C. E. & Calvin, J. (2009). 'How a Novice Adult Online Learner Experiences Transactional Distance'. *The Quarterly Review of Distance Education*, 10 (3), 305-311.

Strang, K. (2013). 'Cooperative Learning in Graduate Student Projects: Comparing synchronous versus asynchronous collaboration'. *Journal of Interactive Learning Research*, 24 (4), 447-464.

Swanwick, K. (2009) *Teaching Music Musically*. London, Routledge.

Tait, H, & Blaiklock, B. (2005). 'Outreach, Piano Pedagogy and the Future with Technology'. Australasian Piano Pedagogy Conference. Adelaide, Elder Conservatorium of Music.

Watts, L. (2016). 'Synchronous and Asynchronous Communication in Distance Learning: A review of the literature'. *The Quarterly Review of Distance Education*, 17 (1), 23-32.