

Overcoming the ‘tyranny of distance’ in instrumental music tuition in Australia: The iMCM project

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Abstract

Instrumental and vocal music students in regional and remote areas of Australia are often significantly disadvantaged in their development by the lack of local teachers who specialise in the instrument being learned. The current rollout of National Broadband Network across Australia offers the potential for overcoming this geographical disadvantage by providing specialist online tuition through videoconferencing. This article reports on an investigation of technical and pedagogical issues associated with synchronous online instrumental tuition. The outcomes from laboratory- and field-based trials included identification of optimal hardware and software delivery systems as well as pedagogical considerations for optimising online instrumental learning.

Keywords

Instrumental pedagogy, vocal pedagogy, online music teaching, music education, rural communities, internet learning

Introduction

When compared to their city counterparts, those living in Australian rural and remote communities experience disadvantages that limit their access to a variety of cultural engagement opportunities. For example, students growing up in small rural communities in Australia often do not have access to specialist tuition from adults living within their community. The default position is that these students will probably be taught either by teachers of other instruments or by amateur musicians, neither of whom specialise in the particular instrument being learned. In such situations, students may need to travel long distances to where specialist tuition is available, which is costly in terms of parent and student time and in financial outlay. The lack of specialist musical training for performing musicians during their early years of music education can adversely affect motivation and severely limit progress (see Pitts, Davidson and McPherson 2000). Putting aside other socio-economic factors affecting access to music education, this 'tyranny of distance'¹ may be contrasted with the opportunity to be taught by specialist instrumentalists that young people living in cities have.

The Internet Melbourne Conservatorium of Music (iMCM) Project was based on the belief by a team of researchers at the University of Melbourne that the situation described above needed to be addressed. It was also based on the opportunity presented by the ongoing rollout of the National Broadband Network (NBN)² across Australia and the anticipated increase in the use of online technologies by education departments, regional education authorities and private providers to offer a wide range of musical opportunities to Australian communities, particularly those in remote areas.

Although online learning is now widely used in many sectors of education, there has been comparatively little attention given to its application to instrumental music tuition in Australia. Online delivery of music content that focuses on music history, aural perception, music theory and similar areas is now widely available within asynchronous learning environments. However, the teaching of music performance – both instrumental and vocal – requires a synchronous learning environment in which a high degree of teacher-student interaction is necessary, where visual aspects such as body posture, breathing, psychomotor manipulation on an instrument require multiple video cameras and/or zooming capability, and where high quality audio with a full frequency spectrum is required. In addition, the degree of latency (total signal delay) between teacher and student locations is a significant issue. These factors highlight the need to more fully investigate, trial and evaluate these technical issues as well as pedagogical methods, strategies, protocols, techniques and content materials applicable to online music performance teaching, all of which formed part of this project.

An early study that explored the potential of the internet to teaching instrumental learning to students in remote and regional areas in Australia was undertaken by Austin Bond (2002); this took more of a theoretical than practical approach to the topic. Some other useful studies were also undertaken during the early years after 2000 (Tait and Blaiklock 2005; Lancaster 2006, 2007; Anderson 2008) but there has been comparatively little investigative work undertaken in the past decade.

Research Issues and Scope of the Project

The iMCM Project sought to address three broad issues: how to overcome geographic isolation – the ‘tyranny of distance’ – that presently limits students’ opportunities for instrument and vocal learning; how best to utilise the NBN’s capacity to provide reliable, fast bandwidth of a scale not previously available in Australia for instrumental music teaching and learning; and how to utilise recent technological developments to expand possibilities for online instrumental music tuition.

These issues were considered from two perspectives. First, the project aimed to identify, trial and evaluate web-based videoconferencing infrastructure (both hardware and software systems) to ascertain the optimal system(s) currently available. These trials involved laboratory-based testing at the University as well as field-based testing at the rural school location. Second, the project aimed to trial and document methods and techniques for implementing online teaching.

The project was therefore undertaken in two phases: a preliminary investigation of these two aspects from existing sources of information and laboratory testing, and then the investigation proper that utilized a Participatory Action Research approach for trialing, evaluating and documenting a series of online instrumental music lessons.

Phase One – Preliminary investigations and Findings

Review of the Literature

An integral part of the preliminary phase of investigation was a review of the literature relating to the delivery of instrumental music tuition through the internet and, more particularly, through teleconferencing. This review was undertaken by the research assistant attached to the project (Barrata 2013) and led to a second report that identified the key elements of an effective audio-visual collaboration incorporating technical, interactional and pedagogical aspects (Barrata 2014a). The findings from these sources provided a basis for the development of some of the key ‘points for discussion’ which identified potential themes and issues for the second phase of the project.

The review of the literature covered both synchronous and asynchronous means of providing musical tuition for students located remotely from the teacher. Two-way synchronous audio-visual communication was considered to be the optimal means for delivering online music tuition and facilitating online music performance over long distances. However, several issues were identified that related to technical matters, to the additional pedagogical skills and ‘mindset’ required of online teachers, and to curriculum development and delivery aspects. Given the stated issues to be investigated, only those aspects related to synchronous delivery were seen as directly applicable to the present project.

The most relevant literature sources considered included the following: Ruippo (2003) that documented work at the Sibelius Academy in Finland, Tait and Blaikock (2005) that outlined experiences at the Riverina Conservatorium of Music in New South Wales, Duffy et al. (2012) that described the use of the Remote Tuition System (IP-based Polycom videoconferencing) at the Manhattan School of Music, New York, and Allochio

et al. (2012) that explained the use of LOLA (LOw LATency audio visual streaming system) at the Conservatorio Tartini at Trieste, Italy. Another LOLA project described by Ferguson (2015) was a real-time engineering case study that involved a collaboration between sound engineers and musicians at Edinburgh Napier University and at the Music and Dance Faculty (HUMA) at the Academy of Performing Arts in Prague.

Classified according to technology, pedagogy, and continuing professional developmental, these projects demonstrated the following.

Technology

- Internet-based video archives should be used so that students and teachers can record and upload performances for review (Ruippo 2003).
- Given the likelihood of network congestion, use should be made of MIDI keyboards to allow low bandwidth transfer of music notation (Ruippo 2003).
- Equipment at both ends must be fully compatible for successful online tuition (Tait and Blaikock 2005).
- Ideally, teachers should have a 360° view of the student in order to check posture, hand position, etc. (Tait and Blaikock 2005).
- Good verbal communication is essential to ensure that performance health issues such as undue tension in hand positions do not occur (Tait and Blaikock 2005).
- Given that the audio system in most videoconferencing environments is designed for speech transmission, special CODECs (music mode) should be developed to allow for larger frequency and dynamic ranges (Duffy et al. 2012).
- Even multiple fixed camera setups cannot always allow adequate views of students performing; accordingly, a roving (fully mobile) camera controlled by the teacher should be available (Duffy et al. 2012).
- Systems should be developed to give complete control over room acoustics (microphones, speakers, echo, reverberation) at each end, together with high quality, high speed video capture and processing (Duffy et al. 2012).

Pedagogy

- Synchronous teaching requires more teacher preparation than asynchronous teaching and teachers need to more closely evaluate the extent of students' participation (Ruippo 2003).
- Teachers must give students more responsibility for their own learning than in the normal face-to-face teaching situation (Ruippo 2003).

Continuing Professional Development

- Music teachers involved in online tuition must have high level ICT skills (Ruippo 2003).
- Student-teacher interaction through non-verbal communication is needed as synchronous activities take up less than 15% of typical lesson time (Duffy et al. 2012).

A review of key elements for effective videoconference communication for instrumental music teaching and learning followed. This review drew on many of the authors cited above. Using the same categories of technology, pedagogy and continuing professional development, the review revealed that the following factors need to occur in order to ensure the successful implementation of online instrumental music tuition.

Technology

- Ensure the network latency and bandwidth are sufficient for the intended purpose and the data transfer required.
- Ensure that hardware and software that process video and audio and the rendering and display systems do not add too much latency.
- Ensure that cameras, microphones and speakers are placed appropriately and in sufficient numbers to meet expectations in sound audio and video quality. Also, the power rating of the sound reproduction system should be sufficient to achieve the required level of dynamic range.
- Consider the need for the position of cameras to be adjustable by the remote participant.
- Control systems should be considered for switching camera views, etc.

Pedagogy

- Develop specific curricula to ensure maximum effectiveness of the technology.

Continuing Professional Development

- Ensure that teachers are highly skilled and experienced and that both teacher and student are suitably trained to make effective use of the technology.

Review of Technical Aspects

The above review drew on the experiences of overseas and Australian initiatives relating to the delivery of instrumental music tuition through teleconferencing. The two initiatives that stood out as being the most comprehensive and advanced in this field were: (i) the LOLA System (LOW LATency audio visual streaming system) undertaken at the Conservatorio Tartini at Trieste in Italy, and (ii) the McGill Ultra-Videoconferencing System at the McGill Ultra-Videoconferencing Research Group located at Centre for Interdisciplinary Research in Music Media and Technology at McGill University in Montreal, Canada (Baratta 2014b).

The key findings from these initiatives focused mainly on technical rather than interactional or pedagogical aspects. Nevertheless, without the minimizing or hopefully eliminating of technical impediments, other aspects cannot be addressed in a meaningful way. The findings from this review (Baratta 2014b) are summarized below.

- Large LCD screens should be available at both end points to provide the illusion of co-location.
- High quality, full spectrum and low latency network connections should be available with the ideal maximum two-way latency being 60 milliseconds or less.
- The audio stream should be capable of delivering the full audio spectrum from 20 HZ to 20 kHz.
- Video compression should be avoided as it contributes to signal delay.
- Network latency may not be the most significant cause of signal delay and a more useful metric to work with is Total Signal Delay (TSD) which is the total time taken from image capture by the video camera to image display on the remote monitor.
- The factors affecting TSD include: (i) image processing at the camera, (ii) video card processing, (iii) video encoding, (iv) network transmission speed, (v) video decoding, and (vi) image display on the remote monitor.
- TSD affects the audio signal as well as the video signal although to a lesser degree because the volume of audio data is much lower with less digital processing being required.

- Synchronisation of the video and audio signals, usually handled by the teleconferencing software, is highly significant in obtaining an acceptable teleconferencing outcome.

All of these findings formed the basis for the 'points for discussion' relating to technical issues that formed part of the Phase Two of the project.

Phase Two – Participatory Action Research

Research Procedure

Addressing of the technological issues involved collaboration between the project team, an on-staff technical officer at the Melbourne Conservatorium of Music and staff from the Institute for Broadband-Enabled Society (IBES) (now the Melbourne Networked Society Institute) at the University of Melbourne. The process involved identifying, trialling and evaluating the effectiveness of several hardware and software systems over two possible internet connections – the National Broadband Network (NBN) and AARNet³ – between the iMCM Teaching Studio at the Parkville Campus and the rural test site at Ballarat Clarendon College (BCC). The approach taken – participatory action research – effectively paralleled that taken for the pedagogical investigation described below.

The commonly-accepted model for action research in curriculum and/or pedagogical development and implementation is the cyclic pattern of planning, implementing (putting into action), observing and finally reflecting, before entering the cycle again (see Figure 1).

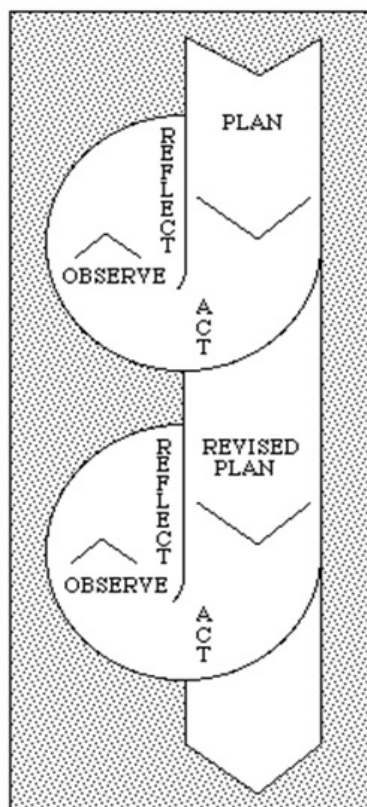


Figure 1: Diagrammatic representation of participatory action research design (adapted from Kemmis and McTaggart 1988: 11).

According to Adelman and Kemp (1992: 116), the criteria to be applied to ensure an effective action research procedure are:

1. inquiry by a group, about issues of practice, using discussion, making group decisions about what to monitor
2. keeping records of the inquiries
3. meeting regularly to consider progress
4. helping each other to reflect on the issues
5. devising feasible ways of changing part of practice to effect the desired change
6. monitoring the consequences of the intervention, and
7. evaluating individually and as a group the worth of the intervention and the status of change, if any.

Participatory action research data are most usually recorded by teachers in journals and may include notes on teaching problems, student profiles, anecdotal comments made by students and other teachers, student essays and diaries, and notes on the trialling of new teaching techniques and materials. The data are then sorted and analysed according to criteria determined by the problems at hand, by themes / issues identified as a result of a search of existing research literature, and by themes / issues that emerge in the course of the action research process. This approach was utilised for both the technical trials and the pedagogical investigation.

Participants

The project participants included three instrumental music students at BCC who were undertaking instrumental performance studies in contemporary voice, oboe and drums. These students were in year 11 of their secondary school education and all had achieved reasonably high proficiency on their instrument or in singing in preparation for their end-of-school (year 12) music performance assessments. There were also the three specialist instrumental music teachers employed to provide online tuition from the Parkville Campus as well as the students' instrumental music teachers at BCC, the supervising teacher at BCC, the technical staff from the MCM and the IBES, and members of the research team.

Data Collection

Data for the technical evaluation of hardware and software systems came initially from the report on technical issues and criteria for optimal videoconference-based communication prepared by the research assistant (Baratta 2014b) described above. Additional field-testing data consisted of notes from meetings of the project team, the MCM technical officer, and staff from the IBES, together with the journal entries on the theme of 'technical aspects' provided by the online instrumental music teachers. Data utilised for the identification and development of pedagogical methods and techniques and interactional protocols for online instrumental music teaching and learning came from the journal entries of the three instrumental music teachers, the school-based supervising teacher and feedback from the three instrumental music students.

Data Analysis

The background report on technical issues and criteria for optimal videoconference-based communication prepared by the research assistant (Barrata 2014a) – which are discussed in the literature review below – provided not only the contextual background for the project as a whole, but also informed the development of the ‘points for discussion’ that were utilised by the online instrumental music teachers for their journaling. These became the initial set of themes for identification in the data which were later supplemented by ‘emergent themes’ as these became apparent.

Laboratory-based testing of hardware infrastructure and videoconferencing software involved members of the project team, MCM technical staff and IBES staff. Several possible solutions to specifically address the issue of latency were tested, the results of which are summarised below.

There was also field-based testing of hardware infrastructure and videoconferencing software together with other aspects relating to the interactive and pedagogical experiences of the participants at both BCC’s and MCM’s online teaching studios. This part of the investigation was based on the action research approach described above and drew on documentary data in the form of the online teachers’ weekly journal entries, periodic feedback from the instrumental music students, notes of and/or transcriptions from recordings of team meetings, and summative reports by the online teachers and the supervising teacher at BCC. A qualitative data analysis software package – *QDA Miner 4* (Provalis Research) – was used for coding, annotating, retrieving and analyzing the collection of documents that represented the data for this project. All of the text-based data was arranged chronologically and loaded into *QDA Miner* as a series ‘cases’. The various sections of text from each of these cases was then analysed in terms of the merging of some of the ‘points for discussion’ which were coded as follows:

- 1.0 Technical aspects
 - 1.1 Hardware and software
 - 1.2 Audio quality
 - 1.3 Video quality
 - 1.4 Latency
 - 1.5 Connectivity
 - 1.6 Camera / microphone placement and adjustment
- 2.0 Interactional aspects
 - 2.1 Teacher-student interaction / communication
- 3.0 Pedagogical aspects
 - 3.1 Differences between contiguous and online
 - 3.2 Advantages of online teaching
 - 3.3 Challenges of online teaching
 - 3.4 General observations on online teaching

The coded data was then exported to an Excel file where it was sorted initially according to the themes and then chronologically to enable a ‘developmental’ perspective of the respective themes.

Phase Two - The Data

Data from laboratory-based testing of hardware infrastructure and videoconferencing software

For the most part, possible hardware and software were identified tested and evaluated at the IBES's digital laboratories located at the Parkville Campus. In view of Baratta's (2014b) report that highlighted the potential problems associated with latency, it was recognised that the optimal network connection between The University of Melbourne and BCC in terms of speed and reliability was an AARNet connection rather than the NBN connection available through a commercial Internet Service Provider. BCC had a 300/300 Mbps fibre connection with 30% of capacity being allocated to the Instrumental Teaching Studio at the school. This could in fact have been increased to more than 70% had any problems been encountered in this regard as only a fraction of the school's capacity was being used.

While the internet connection is important, there were other components in the system that were much more likely to be a cause of significant latency. A typical videoconferencing endpoint consists of a digital video camera, one or more monitors, a microphone, other input devices such as keyboard and mouse all connected to an internet-enabled computer. In order to reduce the internet bandwidth use, the video and audio signals are compressed prior to transmission and then decompressed at the receiver to output on the monitor or speaker. Each of these components and operations involved some degree of latency. However, it was recognised that latency could be significantly reduced if the signal delay caused by software could be minimised by using 'hard-wired' encoder/decoder 'boxes'. Several encoder/decoder boxes were tested but, when put together into real end-to-end systems, the total signal delay between endpoints was disappointing with delays of 500 to 1000 milliseconds being common.

The conclusion from this investigation was that, for systems that are going to be widely deployed, latencies of greater than 60 ms (the threshold of human perception) or 150 milliseconds (the design standard for telephony) are likely to be a fact of life for the immediate future. Adjusting the teaching approach to accommodate this limitation seemed to be the best way forward.

Several web-conferencing platforms were considered as having potential for this project. *VSee* (VSee Lab, LLC) was trialled for the project during the first one-and-a-half school terms but proved to have both video display and audio quality deficiencies. Unlike the system that supplanted it later (*Zoom*), the audio aspect of the web-conferencing platform was fixed to a run speed of 16 Mhz and there was no software application that could enhance the audio aspect. *Zoom* (Zoom Video Communications, Inc), on the other hand, had superior video display and audio quality and the client software could support Silk audio codec⁴ and Opus audio codec, both of which have the capability of extending the frequency range appropriate for the speaking voice to that required for musical instruments.

Data from field-based experiences of technical, interactional and pedagogical aspects

As outlined above, the 'points for discussion' supplied to the online teachers as a guide to writing up their weekly journal entries and also used to frame discussion at team meetings formed the basis of data for analysis.

Technical aspects:

- Equipment–hardware and software

Given that neither the online teachers nor their students were ‘tech-savvy’ to begin with, all participants appeared to recognize the potential for online instrumental music tuition and to exercise considerable patience in order to realize this potential. Nevertheless, there were obvious frustrations as exemplified in this journal entry early in the project by the contemporary voice teacher:

[My student] had started up the session on her own and was getting vision but no sound from us. We checked all the possible problems at our end, but all looked in place. I initiated use of the chat function to communicate and suggested [that she] might need to check that her speaker was on. She needed to go and find [her supervising teacher] for help, and it turned out that the volume on the computer was on but turned down to 0.

The oboe teacher also conceded early in the project that problems with equipment were ‘par for the course’ and needed to be accommodated in order to achieve the desired learning outcomes:

Today's lesson was much better in terms of educational outcomes for the student. ... I have adapted to teach within the limitations of the technology. This means that I have to accept the slightly distorted sound (especially at the start of notes), the delay in sound and the slightly fuzzy vision on screen.

When the web-conferencing platform changed from *VSee* to *Zoom*, all participants were pleased with the improvement. For example:

Today's lesson was the most productive session ... The new *Zoom* software was significantly better than *VSee*, due to the vision being much clearer and the sound issues much more manageable.

- Audio quality

The two issues identified related first, to technical problems with audio transmission and second, to the limited frequency range which limited perception of the full audio spectrum of the musical instruments. Both these issues were highlighted by the oboe teacher:

The only issues [I have] relate to sound. I suspect it had to do with the audio settings at [the student's] end, whereby the microphone would automatically adjust to the varying sound/frequency levels of the oboe. As she gets tired, as with most oboe students, her sound gets significantly brighter (or less flexible, more overtones etc.). Indeed, it was at the end of the lesson when I noticed the microphone compensating for this loss of tone by 'muting' the sound that I was receiving. I will see if we can adjust these settings next lesson. But the distortion experienced in *VSee* is not present with *Zoom* which is fantastic.

However, the overriding issue of sound within the online environment not equating to a normal room acoustic was of concern to the contemporary voice teacher:

Regarding sound quality, I have never heard [my student] sing in a normal room acoustic. I really don't know what her vocal sound is like and I wouldn't really be comfortable in giving a full assessment of her vocal

technique. There is a lot you can gain from the subtleties of a normal room acoustic, especially when the sound depends on how close the student is to the microphone and what direction she is facing. An occasional face-to-face meeting would help in this regard – i.e. mixed mode tuition could be the way to go.

- Video quality

This appeared to be less of an issue than audio quality. Nevertheless, many aspects of teaching a musical instrument require the teacher to visually assess the student for fine motor skills and so poor video quality can be a problem as the oboe teacher reported when using *VSee*:

The picture was quite fuzzy as well. This may be a symptom of the large screen. I may try and reduce the picture box which may improve picture quality. The problem this causes is an inability to see fingers and embouchure (mouth set-up). I will ask [my student] to play closer to the camera at various times in the next lesson to see if this improves things.

- Latency

The issues were discussed above from a technical perspective, but what emerged from teacher and student experiences were two considerations. The first was latency that occurred between the audio and video ‘feeds’ as described by the drumming student:

One of the main constraints was the lag between the sound and the image. This made the lessons especially difficult being a drummer, because the sticking did not match up with the sound ... this created a problem which can only be overcome by fixing the lag issue.

The second consideration was the problem of student and teacher playing synchronously, but the issue was not as apparent with *Zoom* as with *VSee*:

When things were running smoothly it was pretty easy to have a lesson. I could play, [my teacher] could critique, I could play again implementing the things he had suggested, he could play for me. The slight lag between the two of us meant that he could not count or click while I played, and we could not play together, but the lag was very minimal in comparison to other video programs I have used (i.e. Skype). [Drumming student]

- Connectivity

It was assumed that use of the AARNet ‘pipe’ would result in minimal internet connectivity problems. While this proved to be the case, there were problems identified as connectivity issues that resulted more from the participants’ own lack of technical know-how than any disruption to the internet connection as was reported by the oboe teacher:

Today's lesson began with the first issue we've had with connectivity. I was waiting for close to half an hour as technical issues were overcome at the Ballarat Clarendon College end. I believe the delay was due mainly to the fact that [the supervising teacher] was not at school at the time and my student and another teacher were having issues logging in to the *VSee* account. Eventually visual connection was established; however, it did take a few more minutes to establish audio connection. I guess these types of issues highlight the challenges with web-based teaching. Much time

(and manpower) is needed in the instance that the primary users (student and teacher) are not familiar enough with the technology to overcome these types of connection issues.

- Camera / microphone placement and adjustment

This issue proved to be fairly significant, not just from the technical perspective of ensuring optimal video and audio quality, but also from a pedagogical perspective. This was most apparent in oboe lessons where aspects of embouchure are critical to obtaining the correct sound. The following comment from the oboe teacher concerned illustrates the need for image clarity and the ability to focus in particularly on the embouchure.

Sound is still distorted when [my student] plays, and vision is still a little blurry when looking at embouchure and finger technique. I do tend to gravitate towards the camera when correcting finger technique which [she] can see well. It is still hard to get a true sense of the embouchure position however. It is very difficult to ascertain how much reed is in the mouth (which is an aspect of tone control on the oboe) and how much the student is 'tucking' the lips around her teeth.

Both camera position and microphone placement were also issues from the oboe student's perspective:

The camera in my room has been positioned high on the wall giving a whole picture of the room. Therefore, it has been difficult for [my teacher] to see my reed, mouth, breath and fingering ... I am often restricted to a certain position in the room so I am the correct distance from the microphone.

Interactional aspects:

- Teacher-student Interaction / communication

There were obvious limitations to teacher-student interaction within the online environment. Aspects that limited the interactive process were commented on specifically by the contemporary voice teacher and the oboe teacher. For the contemporary voice teacher, there were several limitations as outlined in the following journal entries a week apart.

Musically, interaction was still challenging, although easier than last week, and I suspect it was as good as it could be with the current technology we're using. The real challenge is not being able to work together musically. Aside from not being able to accompany the student the way I usually would, what I found even more difficult today is that I can't sing with her when introducing new material. For example, after demonstrating a new exercise, the next step would usually be to sing along with students so that they can grab onto what I'm doing. This gives them a chance to match what I'm doing as an interim step, helping them to physicalize the exercise by hearing their own voice matching what they hear from me. Without this step, it was too much to expect [my student] to be able to complete the exercise this week, and the best I felt I could do was give her as much of an explanation and demonstration of the exercise

as I could and encourage her to work on it at home to be able to show me next week.

Conversation was even easier this week, and I felt that we could communicate verbally with each other very clearly. I feel that both [my student] and I are becoming more comfortable with the situation – perhaps getting to know each other better as well as being more familiar with the technology and its challenges.

The preceding statement implies what the oboe teacher made somewhat more explicit; namely that, as both teacher and student were able to interact more naturally with increasingly fewer technical issues, they experienced a greater degree of autonomy within the online environment.

Today's lesson went very smoothly. We (the student and myself) are at a stage now where we are able to control every aspect of the lesson ourselves. I still need some help occasionally if recordings of the lessons get saved to random locations on the Mac (as happened today) but this is only an issue of using a shared computer (settings get changed etc.) and of me still getting used to different operating systems (Mac vs PC). But for all intents and purposes, things are working very smoothly and more or less without technical support.

The extension of a more natural interaction between teacher and student was the development of a personal relationship between these two people. One of the strengths of the one-to-one instrumental music teaching situation that all students experience is the close communication that they have with their teachers. Something of this relationship became evident in the following journal entry by the oboe teacher.

Today was a productive lesson in terms of establishing a deeper bond between teacher and student. I spoke with [my student] about her past performances and exams that she has been busy with over the last few weeks. We also touched on repertoire choices that she may make as she embarks on Year 12, and the performance recital that she will give at the end of next year as part of her music studies.



Figure 2: The online learning environment at the MCM

The photograph above shows the iMCM studio at the Melbourne Conservatorium of Music with online music tuition being provided by the contemporary voice teacher to her Ballarat Clarendon College student.

Pedagogical aspects:

- Differences between contiguous and online teaching

Despite the most obvious difference between the face-to-face teaching environment and that of online tuition, there are issues that are particularly significant in music performance teaching. For example, the drum teacher commented that there is a difference in temporal perception.

The main difference is real time versus video time. Rhythm and time are the key parts of drum teaching so there was a difficulty in making this [aspect] part of an online lesson. I am already thinking about changes of methods to better facilitate the online lesson. Something as simple as making sure [my student] has a metronome as well as myself.

Another situation, described by the contemporary voice teacher, was the difficulty of establishing and maintaining discussion in the online environment.

As usual with a first lesson, it takes time for the student to get comfortable and for me to get a sense of where they are at technically and what they're interested in musically. I would usually offer the student a little about myself in return to encourage discussion and find a way to engage with a student, which I believe to be an important part of the student-teacher relationship in a one-on-one lesson structure. The difficulties in communication did hamper this process somewhat, and I realise I didn't

get much of this discussion happening at all. I was able to ascertain areas that [my student] would like assistance in, and I think with preparation and some email communication between sessions, we should be able to use the next lesson more efficiently.

The main differences between contiguous and online teaching identified by the on-site supervising teacher were succinctly stated as ‘not being able to play together or touch the student to adjust physicality’. Both these aspects had hitherto been crucial in providing students with an optimal instrumental music learning experience and to a lesser extent with vocal music learning as well. However, these aspects may to an extent be counterbalanced by the advantages of the online environment identified below.

- Advantages of online teaching

As anticipated the principal advantage of videoconference-based tuition was that this medium allowed students in this rural setting to access specialist tuition that otherwise would not have been available in their local area. This point was well made by the Director of Music at BCC – who acted as the on-site supervisor – with the comment that this medium was the only way that Year 12 students, some of whom were aspiring to undertake further musical training, could access tertiary level teachers with the obvious expertise to enrich their learning. The oboe student whose instrument requires highly specialised teaching remarked:

Having lessons each week using the Internet ... was amazing. I was able to learn so much from a very accomplished teacher, and for an oboe player in a regional area, there are not many oboe teachers. So, it was really useful to learn from someone who had a different perspective and teaching style to the one [local] oboe player I currently (and have always) learnt from.

The same student summarised her experience in the project, stating ‘Overall it has been an amazing experience, especially being an oboe player and only having learnt from one person before, to learn about new techniques and approaches.’

Even with an instrument such as drums, where there is likely to be a greater pool of teachers in rural areas, the student concerned stated that he was grateful to have had the opinions of a someone other than a local teacher: ‘Although there were a few issues with the lessons which could only really be overcome by having lessons in the same room, it was worthwhile to have another view on my VCE⁵ syllabus.’ His online teacher certainly recognised that, at the end of the program, this student has gained significantly from the online experience:

This being the last lesson of term, possibly the last between us, I felt that many learning outcomes had been achieved and that [my student’s] playing has improved. Together with his teacher at school ... I feel he is able to see an overall picture of what lies ahead and how he can improve. The online learning experience, while having technical hiccups, has certainly been a positive experience and one that I can see a future in.

This was endorsed by the on-site supervising teacher who remarked:

Feedback from [the student’s] on-site drum teacher ... was that the online tuition added value to [his] learning of drums. [The online teacher]

covered some different aspects that [the on-site teacher] didn't, so [the student] received a comprehensive education.

The overall advantages of the videoconferencing medium were summarised by the online oboe teacher as follows:

Obviously, the main strength of this program is that one is able to eliminate distance/cost as a deterrent to high quality individual music lessons. It was also extremely helpful to me, as I assume it was to those undertaking the research, to have the program run over such an extended period of time (as opposed to a token few weeks). This allowed a relationship to be built and, while the program was never exclusively about measuring actual improvement in artistic outcomes for the student, I felt that the research (problems etc.) and outcomes were able to be measured in as close to a real-life situation as possible where artistic improvements are expected and are being achieved.

Nevertheless, there were some problems and therefore shortcomings with the videoconference medium experienced by the teachers and students participating in the project. Foremost among these was the problem of latency which is fully discussed below. In addition, there were problems, particularly in the initial stages of the project, with technical aspects such as audio quality, video quality and internet connectivity, as well as placement and operation of equipment in the respective studio spaces. Many of the latter problems were essentially hardware and software issues, most of which were at least partially remedied during the course of the project.

- Challenges of online teaching

One aspect that proved to be highly significant was the choice of the videoconferencing software. The project commenced with *VSee* software which to date has had telemedicine as its primary market. However, despite local technical support, there were on-going problems particularly with sound quality. One of the online teachers commented in his journal entry for the week:

The first three or four lessons were incredibly difficult due largely to problems with *VSee*. There were problems at both ends ... at the technical level but once we established our teacher-student relationship, both of us adapted to accommodate the technology. The key aspect for me was adapting to the different audio environment. Processing in music, particularly with drums, is the relationship of the performance to time. There is also the problem of the spatial direction of the sound. I tended to overly compensate with physical movement – i.e. exaggerate my gestures – in order to try to overcome timing issues – e.g. I gave a large gesture to convey the instruction to the student to stop.

This highlights that fact that most videoconference software has been designed – from an audio perspective – principally for speech rather than music. The frequency response is therefore rather limited which in the case of music makes perception of finer details of timbre and dynamics particularly difficult.

Towards the midway point of the project, the decision was made to transfer videoconferencing software from *VSee* to *Zoom*. The reaction of the online teachers, the

instrumental music students and the supervising teacher was unanimous in finding that *Zoom* provided superior video images and superior audio. The situation was well summed up by the online oboe teacher with the following comment:

The *Zoom* software is working more than adequately, compared with *VSee*, and any problems (such as sound delay) can be easily worked around in lessons. [My student] is progressing very well and I feel as though the consistency of the software has allowed us both to focus more exclusively on the craft of playing the oboe, rather than being distracted by the quality (or otherwise) of the software.

Some weeks later, the same teacher was even more impressed with the superior performance of *Zoom*:

For the first time, I felt as though I knew exactly what [my student] looked like! This has obvious advantages in that I am able to more clearly see the way she sets up when playing (and fix any issues accordingly). I could see her embouchure very clearly and we were able to work (for essentially the first time) on correct set up of the embouchure, working specifically on the relationship between the top and bottom jaw (they should be essentially in line vertically when looking at the student side-on). The improved vision has also had a less obvious benefit in that I feel it has improved the relationship between teacher and student. While this bond takes some time to develop and would naturally be expected to improve at around this stage even in normal face to face lessons, I noted significant improvement today. I put this down in large part to the vision and sound being clearer. We are able to converse more freely and are also able to react and adjust to the various visual cues which one relies upon in all human interaction. In this way, *Zoom* is further advanced than *VSee* in attempting to replicate face-to-face communication.

Unlike, the situation with *VSee*, there was provision with *Zoom* for using an audio codec that would specifically cater for the wider frequency and dynamic ranges of musical instruments and thereby enhancing the sound quality being transmitted to the remote location. Nevertheless, there were frequently problems with audio that related to aspects other than software that included microphone placement, sound distortion, echo, and hardware malfunction. Given the experimental nature of the project, overcoming such problems was generally taken as being a normal part of the teaching environment. The contemporary voice teacher explained one of several such situations as follows:

We had serious echoing problems to begin with, which seemed to be happening at both ends, making it impossible to communicate. It took about 15-20 minutes to get things working well enough to be able to proceed with the lesson. The technical assistant at their end experimented with speaker placement and volume, and checked the mic, and at our end [our technician] changed to a more directional mic. By me using headphones, the echo was eliminated coming from my end and we had things working well enough to proceed with the lesson.

- General observations on online teaching

During the final weeks of online tuition and after the program had concluded, all participants were invited to summarise their experiences. Despite the technical and interactional difficulties experienced by all of the participants, the following comments reflect the general satisfaction with and worthwhile nature of both their experiences of and the future potential of online instrumental music tuition:

I have thoroughly enjoyed being a part of this program. Whether I am making a difference to [my student] as an oboist I cannot be certain as yet, though I'd like to think that she has taken some different approaches to playing the oboe as a result of these lessons. Perhaps more importantly, I hope that the work being done by everyone involved with this project is work that can bear fruit for the University in the coming years, as we expand upon these new possibilities in the teaching of music. (online teacher of oboe).

Overall it [online music tuition] has been an amazing experience, especially being an oboe player and only having learnt from one person before, to learn about new techniques and approaches. (oboe student).

Some worthwhile suggestions for future action were also made by the online teachers:

- Provision of a dedicated online teaching studio:

From an operational perspective, any program going forward would benefit from having the exclusive use of a room specifically for distance learning. While I didn't encounter many issues with room availability, sharing a space with other students at the University meant that there was the odd occasion where lessons could not be given in a particular week. This is a specific problem to me (but also to many other professional musicians) who face differing work schedules every week.
- Provision of technical assistance:

We had one or two instances of the computer at the other end either failing or responding slowly. This highlights the need for both the teacher and the student end needing to be staffed by IT specialist in order for problems to be dealt with in a timely manner. I guess if one was using a standard Skype program, things either work or they don't. Problems could be solved by 'trying later'. In more advanced programs, and especially when using more sophisticated hardware (computers, large monitors, separate microphones and speakers), problems are often unable to be fixed by the teacher or the student, due to their limited knowledge of these systems.
- Provision for periodic face-to-face meetings:

I would also recommend (and especially if the University is looking to officially implement such a program), that 'live' lessons be held at least once every two months. I never met my student in person and while we were able to achieve a fair amount artistically, it would have been beneficial to meet her, not only from a purely relational perspective, but also to actually hear the quality of her sound – to sense the quality of her

instrument and reeds, and to make finer body adjustments (fingers/embouchure) which aren't always visible on screen.

Findings and Conclusion

This project sought to address three key issues. The first was the problem of the geographic isolation of students that limits the extent of their music engagement. The application of online tuition was, by implication, the most likely means through which this problem might be addressed given currently-available technology. The second – an extension of the scenario presented above – was the feasibility of utilizing the National Broadband Network for implementing online music tuition. The third, was the identification, trialing and evaluating of currently-available technological infrastructure for facilitating online music tuition. Parts of the latter aspect involved the application of the technology through human mediation in order to identify optimal forms of interactional and pedagogical delivery of online music tuition.

Overcoming the 'tyranny of distance'

There was ample evidence from participants in this project that online music tuition was a valuable supplement to local face-to-face teaching, a pedagogical approach now commonly referred to as blended learning. Interestingly, none of the participants saw online teaching as a replacement for a local teacher. However, it was readily acknowledged that students benefit significantly from not only having access to online tuition from a specialist in the particular instrument or vocal style being studied (where a local teacher may not be a specialist) but also that an online teacher may bring a different perspective as well as different and perhaps more current teaching methods than his/her locally-based colleagues. Despite the problems and challenges identified, online tuition was seen as a means of overcoming the need to travel long distances and avoiding the cost of such travel to access specialist instrumental music teaching.

Use of the internet for online tuition

Possibly the key factor determining the future development and effective application of online music tuition is that of latency. As demonstrated in the presentation of data relating to all areas of the project (technical, interactional and pedagogical), the current levels of latency present difficulties in both verbal and musical communication between teacher and student. The factors determining the current extent of latency are three-fold: (i) the speed of the network connection, (ii) the hardware, and (iii) the software. Each of these factors necessarily causes some degree of delay in signal transmission but as Baratta (2014a) identified from his review of the literature, the minimum latency should not exceed 60 milliseconds if the interaction between teacher and student is to achieve a workable degree of synchronicity. Much the same challenges were reported in a similar research study undertaken by King, Prior and Waddington-Jones (2019) in North Yorkshire and other rural locations in United Kingdom.

However, in the present study, the issue of latency was the most frequently recurring and therefore dominant theme identified in the teacher journal entries, in student feedback statements and in team meeting records. The lack of 'minimal-latency' synchronicity was identified as limiting concurrent performance by teacher and student as well as small-group ensemble (duo, trio, quartet, etc.) performances. Given that modelling is one of the key teaching strategies employed in instrumental music

teaching, the current lack of a ‘near-fully-synchronous’ performance environment represents a continuing restriction on the effectiveness of online teaching/learning for instrumental and vocal music.

Recent technological developments–hardware and software systems

As outlined above, the project team was guided by IBES staff in identifying several hardware and software that appeared to offer potential for the online delivery of instrumental and vocal music tuition. Several hardware systems were investigated but when put together into real-time end-to-end systems, the total signal delay between endpoints was disappointing with delays of 500 to 1000 milliseconds being common.

Several web-conferencing platforms were identified as having potential for this project. However, given the almost exponential growth of technological development, the steady release of new hardware and software products onto the market, and the likely enhancement of internet communication speeds through AARNet, there is little doubt that many problems and issues encountered in the project will find solutions through future technology-based research and development endeavours.

Identifying the optimal forms of interaction and pedagogy for online music tuition – confirmations and challenges

The technical evaluation resulted in the use of *Zoom* software in combination with AARNet broadband access. This software resulted in greater reliability, enhanced video and audio reproduction and easier operation than the alternative *VSee* system trialled at the beginning of the project. Given the capacity of *Zoom* to accept audio codec, the possibility exists for a codec to be written that could extend the frequency and dynamic range of the audio signal to better accommodate the need for better audio output for music.

Participants’ reactions to the transfer from *VSee* to *Zoom* were positive with both teachers and students being in full agreement that *Zoom* was significantly better in terms of both video and audio output. Despite the problem of point-to-point latency, there appeared to be better ‘internal’ synchronicity between the audio and the video outputs with *Zoom*. Moreover, when the changeover from *VSee* to *Zoom* occurred, all participants remarked on the enhanced video image. Although there was too little time to evaluate the full range of videoconferencing systems, it was clearly apparent from the audio perspective that all currently-available web-based videoconference software essentially caters for the more limited frequency and dynamic ranges of the speaking voice rather than for the wider frequency and dynamic ranges required for musical instruments and the singing voice.

Nevertheless, the data provided by the participants clearly indicated the value of the online music tuition trialled as part of this project. This finding largely accords with conclusions drawn by King, Prior and Waddington-Jones (2019). As amply documented above, all participants in the present study – online teachers, instrumental/vocal music students, the on-site supervising teacher and the project team (including technical staff) – found the experience of online music tuition rewarding at both professional and personal levels.

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¹ The phrase 'tyranny of distance' was coined by the Australian historian and author Geoffrey Blainey as the title of his book *The Tyranny of Distance: How Distance Shaped Australia's History* (Macmillan 1966).

² The Australian National Broadband Network is a government-owned corporation tasked to design, build and operate as a monopoly wholesale broadband provider. The NBN includes wired and radio communication components which is being progressively rolled out throughout Australia.

³ AANet is the Australian Academic and Research Network and is widely regarded as the founding provider of the internet in Australia.

⁴ A codec is coding that compresses data to enable faster transmission and decompresses received data.

⁵ VCE is the Victorian Certificate of Education which is the end-of-school assessment completed at year 12 of secondary school education.