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Laptop computer as instrument in music performance lessons: issues and opportunities

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Abstract

In the 21st century, we are increasingly exposed to music created entirely on computers. This article shows how pioneering music teachers approach the challenge of teaching music on the laptop computer in the context of one-to-one musical instrument lessons. Interviews and observations with five laptop teachers in Norwegian secondary schools enabled the authors to explore characteristic challenges in this field. This study explored two research questions: *What are the instructional strategies, content and 'repertoire' in music lessons on laptop computer? How have teachers experienced the laptop's evolutionary process towards legitimation?*

Keywords: laptop computer; live electronics; music technology; individual lessons

Introduction

It is common in many countries for children and adolescents to take lessons on piano, guitar, violin and other instruments associated with a specific heritage and body of repertoire. Today, laptop computers are ubiquitous in everyday life, serving an array of purposes, and although their utility for such musical activities as arranging, composing and mixing is increasingly understood, laptops tend to have not yet gained full formal recognition as a 'main instrument' for music performance in the context of educational systems. This is despite the fact that a rapidly increasing proportion of music produced in the world today is made almost entirely on a computer, and a growing number of ensembles across various genres incorporate 'live electronics' on a laptop computer in their performances. How do music teachers go about teaching such an instrument with a relatively short history, and how do they creatively negotiate their laptop teaching to fit into formal curricular structures designed for instruments that have stronger connections to heritage and repertoire?

Background and viewpoint

Several recent publications have demonstrated how music teachers can bring technologies into their instruction to meet particular goals in the classroom (Freedman, 2013; Hein, 2017; Kardos, 2017). Artistic innovations, such as Bjork's *Biophilia* app-album, have also captured the attention of educators, with the promise of attracting students to creatively engage with musical sound on their own time through digital technologies (Husby & Hebert, 2019).

Extending on the notion of 'affordances' (Gibson, 2014), Krueger has aimed to map out how we can understand musical practices – including those involving technologies – in terms of the notion of 'extended mind' (Krueger, 2014). He describes the *hypothesis of extended cognition* (HEC) as follows:

According to HEC, the vehicles of cognition need not be confined to the head. Within certain circumstances, artefacts, tools, technologies, cultural institutions – and perhaps even other people – can become part of a spatially extended cognitive system in virtue of the active role they play in driving various cognitive processes such as reasoning, remembering, planning, calculating, perceiving and navigating our environment (Krueger, 2014, p. 5).

Importantly, HEC implies that our understandings of music's possibilities are enhanced by technologies (including instruments), which serve as a creative basis for musical expression. Krueger argues that among the implications of this situation for music are that even passive music listening inevitably entails an *interactive* dimension:

to further understand the motoric dimension of musicking, we must note that music does not merely *cause* us to move and feel in particular ways. The causal chain does not simply proceed in a tidy linear fashion from music (as heard) to action (as caused by heard music). It also runs the other way. The experience of agency is intrinsic to how we hear and respond to music (. . .) there is an irreducibly *interactive* dimension to music perception – even when “passively” listening (Krueger, 2014, p. 6).

This suggests that new technologies may offer unique ‘affordances’ (Withagen & Costall, 2021) that enable musical understandings that would not otherwise be possible. Still, previous studies have also suggested that some music teachers generally continue to be reluctant to adopt technologies into their teaching, often for such reasons as *expense*, *accessibility*, *attitude* and *usability* (Brudvik & Hebert, 2020).

Bell (2015) describes the affordances of a digital audio workstation (DAW) in terms of five P's: *presumptions* (human knowledge for operating the instrument), *privilege* (the affordances most easy to access), *provision* (affordances of the software but hidden under menus), *protection* (hidden, and hard to find without guidance) and *prevention* (actions not permitted in the DAW). Elsewhere, Bell (2022) also describes how humans can find new uses for a technology even when a particular object was not designed with that affordance in mind. For instance, when two turntables were used simultaneously along with a mixer, ‘turntableism’ was invented, which deeply impacted EDM, hip-hop and other major genres (Bell, 2022, p. 194). The same process applied to Ableton Live: the software was first made for DJing, but after musicians started composing with the software, developers refined it into a full DAW with its distinctive horizontal arrangement view option.

It seems undeniable that the curricular decision to offer the option of studying laptop computer as one's ‘main instrument’ formally gives music technology a new kind of status in schools. For such reasons, it seems important to look carefully at how the laptop computer has come to be adopted into music education. This article is based on a postgraduate thesis developed by the first author and mentored by the second author. For the sake of disclosing biases, we briefly note here that as multi-instrumentalists, neither of us hopes to see a situation in which traditional instruments are replaced by laptop computers. Still, we see the laptop computer as a useful way of enhancing musical creativity while broadening the field of music education to attract students who might not otherwise seek out (or at least continue in) study of traditional instruments such as piano or guitar. It is to be expected that students who are enthusiastic about computers generally, including video production and videogames, may be inclined to consider computer music studies even if they have little interest in traditional musical instruments (Jensenius, 2022).

It is also important to note that relative to traditional instruments, some music technologies may be more accessible to students with physical disabilities, and due to the emphasis of many charitable organisations on educational technology, a good proportion of financially disadvantaged students are likely to have access to a computer even if they cannot personally afford a piano, guitar or violin. The laptop is also extremely versatile in terms of the kinds of genres in which it is used, from experimental *avant garde* art music to video soundtracks, and vast array of ambient

and dance music genres (Rambarran, 2017). Finally, use of laptop and related technologies may also support endeavours to broaden music curricula to more effectively internationalise and represent diverse music cultures, far beyond the horizons of students' previous understandings (Hebert & Williams, 2020; Ruthmann & Hebert, 2018). Technology can thereby 'augment how we share music with others, expanding beyond traditional Western concert experiences' (Tobias, 2017, p. 433).

Design and research questions

In order to explore this field, we used a multiple case study design (Stake, 1995). Five laptop teachers were identified through emails sent to schools and selected as participants for the purpose of obtaining a geographical spread of respondents. The data consisted of semi-structured interviews (Kvale & Brinkmann, 2009) and observations. Each teacher was interviewed in depth, an average of 140 minutes total per interviewee. The interview guide was designed with such questions as 'How would you describe a usual lesson from start to end?' and 'Is there some repertoire you deem as important for laptop musicians?'. Data were coded using NVivo for inductively organising the material into themes and cross-analysed for potentially significant similarities and differences.

Much effort was devoted to recruiting female participants (e.g. searches and asking in the Facebook group for female teachers) but regrettably we were only able to identify and recruit male teachers of laptop for the study, which appears to indicate something about the gender imbalance currently seen in this field. Additionally, most of the selected teachers worked at both a 'culture school' (public institution for after-school arts education) and an upper secondary school (Table 1).

As shown (Table 1), three of the participating teachers had studied jazz, while the others were a music therapist and a student in a music technology BA program. Two of those with a jazz background mentioned learning some technology skills in their formal education, but for most their learning of music technology occurred outside formal education.

We are aware of only one previous study to address the teaching of live electronics in one-to-one music lessons in Scandinavia, but it takes place in a higher education context and uses interviews without observations (Sørbø & Røshol, 2020). Through systematic observations, researchers can examine how a social group, a phenomenon or an organisation functions to answer questions about what people actually *do*, rather than only what they are able to *say* about what they think or do. For such reasons, observations of laptop teachers were an especially helpful research strategy for addressing RQ1, while examination of RQ2 relied mostly on interview data. Due to restrictions caused by the Covid-19 pandemic in 2020–2021, direct access to laptop instrument lessons was limited, but two teacher's lessons were observed remotely via Zoom videoconferencing technology and one was observed in person.

For the purposes of this article, we will report on our findings in relation to two research questions: RQ1: *What are the instructional strategies, content and 'repertoire' in music lessons on laptop computer?*; RQ2: *How have teachers experienced the laptop's evolutionary process towards legitimisation?*

Findings

Observations of laptop lessons

It is useful to briefly consider what a laptop instrument lesson actually looks like. Although music technology can be taught through online lessons (Cremata & Powell, 2017), all but one of the observations described in this article were of in-person (face-to-face) lessons. Rather than following a fixed schedule, the teachers described the choice of content for their online laptop lessons as somewhat directed by the student, or based on music, providing motivation for learning

Table 1. Profile of Participants

Participant (pseudonyms)	Ian Kolstad	Inge Weatherhead Breistien	Øyvind Brandstegg	Magnus Fjelde	Anders Paulsen
Formal education	Music therapist (MA)	Jazz (MA), music production one-year study	Music technology (PhD), Jazz (BA)	Jazz (BA)	Music technology (BA) in progress
Instrument(s)	Guitar, laptop/electronics	Saxophone, laptop/electronics	Percussion-vibraphone and drums. Live electronics	Piano, synth, laptop/electronics	Piano, synth, laptop/electronics
Main genres	Alternative, rock/pop, electronic music	Jazz, hip-hop, electronic music	Electroacoustic music, rock, jazz, generative music	Alternative rock, electronic music, jazz	EDM, house
DAW	Ableton Live (Pro Tools)	Ableton Live	Reaper	Ableton Live (Logic Pro)	Fruity Loops
Musical background	Producer, band musician and session musician	Composer, musician and session musician	Composer, performer, band musician, programmer	Producer, band musician	Producer, live-sound engineer, band musician
Teaching background	Upper secondary, culture school	Upper secondary, culture school	Upper secondary, culture school, university	Upper secondary, culture school	Upper secondary

of essential skills. Magnus mentioned that he ‘previously tried some kind of structure in the lessons’ but that recently he takes account of how the student likes to work, like ‘jamming or performance-related activities’ for the first 15 min, or ‘works on projects’ (selecting a song file in the DAW) for the majority of a lesson.

Observation 1: Anders

A first-year student is working on a PC-laptop with FL studio connected to a six-channel mixer and speakers with no external gear added to the laptop. Anders and the student sit shoulder-to-shoulder facing the laptop, and their conversation begins in a friendly, almost ‘peer-like’ way. The student was given an assignment of creating a bass sound from scratch ‘in-the-box’ using a software synthesiser, and the goal of the lesson was to further develop and learn how to combine elements like different oscillators at different pitches, white noise and tonal shaping with ADSR (attack, decay sustain, release) envelopes and low-frequency oscillators. In the lesson, Anders explains different forms and knowledge of synthesis like frequency modulation as well as programming (coding) of synthesisers in Csound, as well as how sawtooth and square waves consist of sine waves stacked on top of each other. Together, they develop the synth sound and venture into another software synth named Sytrus for other sounds and parameters. An hour into the lesson, the student asks Anders how to create a lead-synth sound from an EDM song. Anders instructs the student for 5 min, and then asks if they can change seats so he can explore how the sound was created. He ends up with a similar sound, and then says ‘we are not that far away now if we add a couple of envelopes and some distortion’.

Observation 2: Magnus

In the room are a large mixing console, monitors, analogue compressors as well as a recording room fully equipped with a range of band instruments, capable of housing a large band. A first-year student enters the room. Magnus greets him in a friendly way, and they discuss how the assignment for that lesson has gone. The student plugs his MacBook Pro into the mixer and connects his Push 2 device (Ableton’s DAW-integrated controller) to the MacBook. The student and teacher sit with some distance shoulder-to-shoulder facing the mixer console. The student starts to play an arpeggiated loop, trying to record new elements without the aid of a click track, but struggles to find the downbeat and is unable to successfully record the loop. Magnus suggests that the student could ‘turn on the click-track’, but the student wishes to try again without it, so Magnus says ‘go ahead’. After a couple of attempts, the student adds the click-track and is able to record the new loops of vocal samples, then synth-chords and processed drums. From the speakers one can now hear a full-sounding dirty hip-hop inspired beat, and the student adds a pre-recorded distorted and ‘robotic’ vocal loop on top, making that part into the A-section. Now the student disables the loops one by one, to then record a new chord progression, marking the entrance to the B-section, which is developed with melodic synth-layers on top, to later launch the A-section again, repeating until the student stops the song. All of these actions are performed on the Push 2 MIDI controller, with some interaction on the touch pad as well. ‘Good, that mid-part became somewhat too big, can you filter in the low-end?’ suggests Magnus, and the student adds a low-pass filter. Next, Magnus starts a conversation about how the student envisions the mid-section to sound: ‘Do you want that to be naive and dry or do you want more reverb?’ he says, implying that both can work while mentioning the band Bon Iver as an example of a dry synth sound. The student says he wants this section to be dry, but wishes for a different kind of change in sound, ‘maybe some Vinyl’ (a modulation plugin, making recordings sound vintage). They agree the new sound is interesting, and note that it now sounds similar to the band MGMT. The student packs up and asks about the upcoming band class, mentioning that he brought a TalkBox to school for experimenting within band.

Observation 3: Øyvind

The school studio is a small room (about 10 m²) that contains one multiple-input audio interface, monitors, a MIDI keyboard, computer screen and a window to the next-door classroom which serves as the ‘recording room’. The student sits facing the screen, and Øyvind sits by the same table. In band class, the laptop student is going to perform ‘A Day in the Life’ (The Beatles) in a band consisting of piano, saxophone and two vocalists. The student asks the teacher if the band should play to a click track, and he describes wishing to work with programming drums for the track. ‘Can I hear what you have done?’ Øyvind asks with a friendly tone, and the student loads his project file with pop–jazz inspired sections of music. They start talking about how to make a tempo track, and then work on the string section: ‘can you add some tremolo? If you listen to the original it is more like a chamber orchestra’, Øyvind says. The student opens his orchestra plug-in, showing how he can move the different instrumental sections inside a digital representation of a concert hall. Øyvind starts to talk about how to avoid using a click track, implying ‘it is a bit boring’ if the others have to follow the ‘static metronome’ of the DAW, as this is an unnatural situation for live musicians in some kinds of bands. At the end of the lesson, a new dialogue arises, as the laptop student mentions uncertainty regarding social aspects of the band. Øyvind asks, ‘have you shown them what you are going to do?’, and the student answers ‘no’. Øyvind continues, ‘you shall not be the dictator of the band, but you have to show them what you will do’, explaining about common group dynamics in band contexts. He says that the shorter it takes for the group to know what the laptop musician will do, the easier it can be for them to confidently respond to the ideas the laptop musician created. He then explains ‘if you’ve got something to show them next band class it will be alright’. The student packs up, and the lesson ends.

General lesson tendencies

In other observed laptop lessons, there was dialogue between teachers and students related to issues surrounding the performance. Multiple teachers discussed the importance of the internet as a learning resource, including when it comes to composing for laptop orchestra (cf. Smallwood et al., 2008). Ian went so far as to say that if you want to learn the DAW to create a party song (specifically, he referred to the ‘russelåt’ genre in Norway) you can find YouTube videos to learn everything on the DAW, but if you wish to ‘learn music’ you go to him as a teacher. Ian and Magnus mentioned the use of ‘Mix with the Masters’ (YouTube channel with mix/master and sound engineers discussing how they mix music), and Magnus also mentioned using the YouTube channel ‘Andrew Huang’ for learning about music technology, as well as live performance videos for inspiration in the area of live electronics techniques and solutions for live setup of laptops for performances.

Instructional strategies, ‘repertoire’ and creative tasks

In the observed lessons, the instructional strategies featured a large extent of student involvement, with the teacher acting more as a facilitator of learning than a traditional pedagogue. Lessons often started with a piece of music the student brought to class, followed by feedback from the teacher regarding both aspects of composition and mixing techniques. At the end of lessons, teachers typically provided either open advice for further work, or concrete tasks to prepare for the next lesson. Thus, the instructional strategies were similar, with the teacher generally ‘exploring along with the student’ to a larger extent than guiding students towards an ideal perceived as ‘correct’.

Each of the five teachers mentioned that their use of repertoire in laptop lessons is different from teaching other instruments. Due to its newness as a musical instrument, the laptop computer obviously lacks the heritage of an instrument like piano, which has established expectations of progression, techniques and repertoire considered important for understanding laptop

Table 2. Laptop Repertoire

Ian Kolstad	Magnus Fjelde	Inge Weatherhead Breistein	Øyvind Brandtsegg	Anders Paulsen
Eivind Aarset	Eivind Aarset		Eivind Aarset	
Jan Bang	Jan Bang		Jan Bang	
	Brian Eno		Brian Eno	Brian Eno
Radiohead/Tom Yorke	Radiohead		Radiohead	
	Jon Hopkins		Jon Hopkins	
Erik Honoré	Erik Honoré			
Portishead	Portishead			
Massive Attack	Massive Attack			
		Cashmere Cat	Cashmere Cat	
		Nils Frahm	Nils Frahm	
Skrillex			Skrillex	
Alan Walker			Alan Walker	
		Corey Henry	Corey Henry	
	Imogen Heap	Imogen Heap		
			Kygo	Kygo

musicianship and optimal skill development. Additionally, unlike traditional instruments, the vast majority of assignments in laptop lessons are not geared towards repertoire, but rather are formed as learning activities to create music within given boundaries.

Inge, one of the laptop teachers, offered an assignment to students that uses the artist Madlib's imaginary five-piece band 'Yesterdays new Quintet' as a model. Students are asked to take a similar approach by using the laptop to make their own fantasy four- or five-piece band. Anders, another laptop teacher, also mentioned using repertoire for learning of genre aesthetics, for both mixing and sound design. As Øyvind, one of the other laptop teachers, explained, 'In laptop we compose as a completely integral part of finding the repertoire. Since the repertoire does not exist, we must constantly create something'. Still, attempts to locate the equivalent of 'repertoire' *do* appear in laptop lessons. The observed lesson by Øyvind emphasised how to use the laptop in a band playing the song 'A Day in the Life' by the Beatles. Ian said that he does not use much repertoire as assignments for lessons since the laptop is 'kind of pioneer-work'.

Participants were also asked to identify the prominent laptop musicians who they tend to ask students to listen to as part of their studies. From this list, our analysis suggests that a consensus of what 'laptop repertoire' is especially significant may already be emerging as laptop is institutionalised in education (Table 2). It is important to note that many musicians identified as influential do not directly utilise the laptop, but are nevertheless an inspiration for genre aesthetics, usage of synthesisers, production style or similar elements. Some Norwegian musicians like Eivind Aarset and Jan Berg were mentioned. British composer Brian Eno, usually credited as the pioneer of ambient music, was included by three teachers, and alternative rock band Radiohead was also mentioned, which has multiple recordings that explored the use of electronics (e.g. 'Kid A' album).

Issues in laptop music teaching

Examples of assignments in laptop lessons

The laptop teachers all indicated that working with relevant music is important, and Magnus explained that 'it is stated in the curriculum [that] the music should be relevant', saying that when the student does not perceive the importance of a given song, 'it becomes really boring for them'. This makes it in the teachers' interest to give assignments that the students feel are relevant, such as the following examples:

- **Øyvind:** Record several real-world sounds, which can be anything from dialogue to sounds from a forest. The student will capture nuances in the sounds, and extract motifs and details to later edit and process, creating a sound-sequence with appropriate length for the music. The student's music can develop into anything from a 2-min piece into an ambient and floating 12-min piece, depending on the sounds they create.
- **Inge:** Make a piece of music inspired by Madlib's solo project Yesterdays New Quintet. Make a track which sounds like there are five musicians playing the piece. Record instruments that are edited, chopped and sampled. If necessary, use virtual sound technology for some instruments you do not have available (e.g. Fender Rhodes-type electric piano) and record it into audio afterwards for sampling (cf. Collins, 2007) and editing.
- **Ian:** Make a remix of an artist/band that releases their original audio files online for the purpose of allowing others to remix the song. Learn about remixes and copyrights through the process. Ian describes how the Norwegian metal band Shining released their 'stems' (original recorded tracks) online, saying anyone who wishes can remix, which Ian and students started to do as an assignment. He recommends remixing as an assignment which can be relevant and exciting for the students.
- **Anders:** One student had created a song, and Anders noticed too much compression, equalisation and effects were used. He then created an assignment to turn off the plugins, using only the volume faders to mix the song. This was to demonstrate how one should 'adjust the volume on the tracks correctly' before adding any processing, and to provide perspective enabling students to develop a critical ear.

Challenges to teaching music on the laptop

All teachers except Øyvind mentioned it can be a challenge to motivate students to perform music with live interaction on the laptop. As Inge explained, there are 'many (students) who do not have that background' to be comfortable with public performance. Rather, as autodidacts, working in the producer role is a 'very logical' choice. Still, for some students, live performance can end up being a highly passive act, much like merely activating a playback and processing the sound, absent any risks. Special efforts are needed to ensure laptop musicians perform in a fresh and compelling way that communicates visually with the audience. Another challenging aspect is teaching *mixing*, especially the uses of plugins and being able to understand and hear how they function. Ian mentioned the challenge of 'killing your darlings' since a student's favourite part of a song can turn out to be what the teacher feels must be removed. He also described a challenge to teaching 'how to know when there are enough instruments and frequencies filled out' so a song does not have an excessively thick texture. Anders, on the other hand, mentioned the challenge of teaching students how to even be able to hear what is 'needed' for a mix to sound good, which is a skill that takes time to develop. Anders described one time a student had far too many plugins on his track. His solution was to assign the student a task to mix 'using only volume faders and panning', and then add plugins when the mix becomes balanced. Additionally, Inge mentioned changing student habits as a major challenge since their approaches may have already been used for years and become somewhat ingrained. As Ian explained, much of the skill for a laptop

musician is knowledge of technologies and how to use them, so a laptop musician relies more on cognitive skills than motor and physical skills. As an example, the theory of aural training in more traditional music and within music technology is so different that Øyvind decided to create a new university subject called ‘aural training for music production’, emphasising effects and processing.

Although composition is not explicitly mentioned in the curriculum for the specialised ‘main instrument’ of music study in Norway, there have been experiments with integrating composition into piano lessons at upper secondary school. For the laptop, which shares the same curriculum, our data suggest it would be hard, or close to impossible to learn the instrument without simultaneously creating music. As Øyvind explained, the world of the laptop is enormous, used in a wide variety of genres, with important links to 20th century composers who experimented with tape, microphones and analogue synths. Øyvind mentioned how the actions performed on laptop are ‘detached’ from the sound one hears, just as the unplugged sound from the electric guitar is very distant from the amplified sound. This is one of the elements which can be a root of prejudice towards laptop performance (Cascone, 2003; Marlow, 2009; Williams, 2014). Ian also mentioned that he has encountered the opinion that performing on a laptop resembles ‘cheating’ since it is ‘all playback’. Additionally, as previous studies have shown, the sound quality of digital instruments has become very close to or even sometimes indistinguishable from analogue instruments (Ruiz, Cooper, & Muhammed, 2020).

Affordances of creating a live setup

Various musicians are notable for performances in both DAW-based live looping and loop-pedal-based looping (e.g. Jarle Bernhoft, Rachel K. Collier, Ed Sheeran). Nevertheless, the history of live looping is described as connected to the experimentation of creating music through tape played at different speeds and sequences. Composers like Riley, Stockhausen and Reich were mentioned in interviews as a link to the past before digital technology. Naphtali (2017) has written about live processing and how the ‘live setup’ can be conceptualised as design of one’s own instrument, noting that making the DAW more ‘physical’ through MIDI devices enables electronic musicians to be more active in live situations. Even with a minimalistic setup (e.g. a MIDI keyboard with few pots/faders), the laptop becomes more physical and such a layout affords interesting possibilities for combinations of macros and parameters on the MIDI keyboard.

The challenge of deciding how to perform and what to perform with is described by laptop teachers as a learning process for students, which coheres with findings from Nupen (2017). Making the laptop a more physical instrument through MIDI devices was reportedly an important factor for teachers in the laptop lessons, as physical controllers make the performance more inviting for live interaction and allow for the change of multiple parameters at the same time.

Magnus compared learning new effects to learning a new technique on a traditional instrument. In some observations, the interaction of which parameters to change in the mix was described through linking to nontechnical terms like ‘naive’, as well as known parameters of dry/wet as well as ADSR and frequencies. In this way, the student can ‘own’ the decision to a larger extent, while the opposite would potentially risk the student not feeling similar ‘ownership’ of the music creation.

Inge described the popularity in EDM of ‘writing a track’ (typing in MIDI notes), which in some ways shares similarities with composers creating music using notation as the mediator of musical information for the musician. Instead of writing for an instrumentalist, the DAW itself serves as the musician which without any mistake will play the part from the composer. As Magnus explains, some students are so quick with this tactile technique that they can ‘write’ a piano live, and this action is described to require practice and knowledge of the DAW to perform. Still, all teachers said that they value their ability to play a more traditional instrument and use the laptop as an instrument to sample, loop and process their own playing as well.

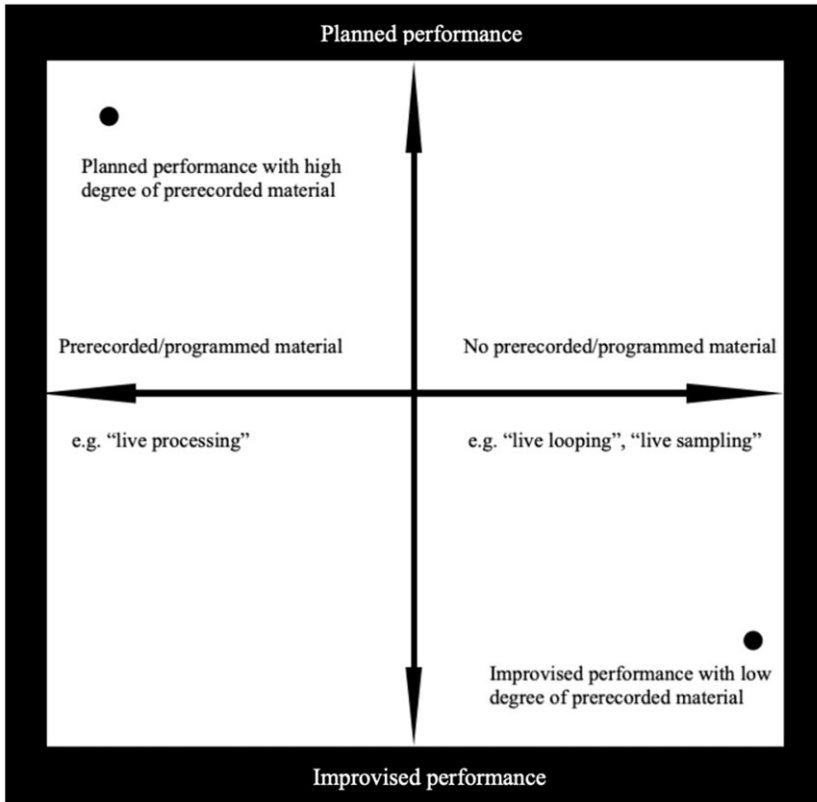


Figure 1. Compass of laptop performance.

Audiences often perceive the laptop musician as less involved in live performance than, for instance, a pianist (Nupen, 2017). As Bell describes, the audience applauds the pianist for the performance, not the piano (2015, p. 52). The view of the laptop as an instrument should be no different, and most of the teachers feel that we are moving towards the recognition of the laptop musician as a fully appreciated instrumentalist (Trueman, 2007; Williams, 2014).

Towards a model of laptop music performance

When a laptop musician performs solo or with other laptop musicians, one can perceive the two main modes of *live processing* and *live looping* as entailing the opposite ends of an axis (Fig. 1).

A laptop musician may perform with pre-recorded material and loop the rest, or can mainly process pre-recorded material to later record and add more, as seen in the ‘live looping performance lesson’ (Observation 2: Magnus). Also, there is the opportunity to improvise as Ian described, or to follow a planned composition as in an observed lesson offered by Magnus. Live sampling is not placed in the figure as it is described mostly in the interviews as a live performance with laptop musicians sampling other instruments or vocalists (Collins, 2007). As shown in the model (Fig. 1), when performing solo or with other laptop musicians, the performance can be placed at some point in the ‘axis of live approach’ (horizontal, from ‘live processing’ to ‘live looping’) and at some point in ‘the axis of planned performance’ (vertical, from ‘planned performance’ to ‘improvised performance’).

Note that even though the horizontal axis describes processing, it does not imply that the performer processes at that end of the axis, but rather that it is perceived an approach residing at

that end of the spectrum. Also, the dynamic nature of laptop performances gives room to transition from improvised approaches into a planned sequence, even mid-performance. The above figure can also incorporate other performance situations, such as live coding, or performances using live electronics without laptop. At least one school refers to laptop-as-instrument using the generic term ‘sound’ (Fagerlia VGS), while one school in Oslo uses the term ‘live electronics’ (Edvard Munch VGS). As Inge mentioned, ‘this opens to different approaches’. Such terminology directs the content and affordances opened by more external gear in performance, to even going ‘DAW-less’ by syncing together samplers, sequencers and synths in performance situations without a computer involved (Knowles & Hewitt, 2012).

Legitimation of laptop as an instrument

Based on the results of this research, we can also briefly address a related question in the discussion: *How have the teachers experienced the laptop’s process towards legitimation?* The mechanisms of institutionalisation that enable new practices to become widely accepted in music education have been explored in previous publications (Hebert, Abramo, & Smith, 2017). Some laptop teachers sense that the legitimation of the instrument is lagging behind in circles that have less familiarity with electronic music. Some teaching staff also perceive the laptop as ‘just a buzz’ (Ian), simply a trend within upper secondary schools. The producer wave in Norway is mentioned as a factor contributing to the instrument’s availability in upper secondary schools, which affects student application numbers and has ultimately also opened possibilities for learning performance with live electronics. The teachers explained that the schools where they teach offered laptop either because of the wish to be ‘modern and relevant (to the music in society)’ (Inge, Magnus) or that students have applied specifically to learn laptop (Ian). Øyvind explained that the first student at his school applied for laptop lessons for 2 years, and finally received teaching from Øyvind during the final year of upper secondary school. A problem for the laptop’s legitimation can be that one does not ‘need’ to practise physical technique for years to be able to create sound. Still, the laptop musician learns to utilise a vast amount of skills related to both cognitive skills and technical knowledge. Also, it is harder to connect performed actions to music in live performance, which may have impacted legitimation. According to Magnus, creating links and comparing laptop to instruments like the organ, and rooting laptop history to the evolution of synthesisers, sequencers and samplers have been effective for legitimation among other teaching staff and school administration. Also, the Facebook group created by Magnus has impacted the laptop teacher milieu in Norway, by gathering teachers in an online forum for sharing of relevant experiences and pedagogical approaches.

The teachers had different perspectives about how applicable the national ‘main instrument’ curriculum is with the laptop as one’s musical instrument. Magnus created a ‘translated curriculum’, aimed at providing practical examples of how one can achieve curricular goals on the laptop. The curriculum was presented at a conference in Norway with the goal to ‘bridge the gap’ and legitimate the instrument among music teachers in upper secondary schools. Inge also mentioned having used Magnus’ ‘translated curriculum’ to meet the national requirements. Øyvind, on the other hand, described the curricular goals as open and achievable on all instruments, and suggested the requirement of ‘connecting modes of expression to genres and epochs’ in the case of the laptop merely refers to different genres and epochs than would be applied to a classical guitarist. Anders sensed that although the curriculum goals are achievable, he would value a more instrument-specific plan, especially when it comes to evaluation of his students’ work. Ian, on the other hand, found many curriculum goals to be challenging and not as applicable to the laptop as more traditional instruments. In the new Norwegian curriculum in 2020, some specified curriculum goals were removed (e.g. *prima vista*, or ‘sight-reading’ of notation), which created more room for content in the teaching practice. Regardless, the curriculum goals can be perceived as so open that the teachers can attain them through their

teaching on laptop. The teachers argue for the laptop as an instrument because of its wide array of affordances to create and process music. Additionally, they note that it serves as both a specialised ‘main instrument’ and as a production tool for traditional musicians to record, compose and alter their musical creations. Moreover, the widespread use of the DAW in music production and the increasing use of digital instruments in the popular music scene have made learning a DAW a major advantage in the world of the entrepreneurial musician, who can fill all roles from recording to release, by themselves.

A related point to keep in mind is that of *employability*, for in the field of music technology and DAWs there are potentially additional forms of income-generating work for musicians. A traditional instrumentalist uses their skillset on their instrument and earns income through playing or creating music (which, as we have shown, often can be supplemented with skills on laptop). However, in the field of music technology one can also work as a sound engineer for studio recording, live recording, mixing, mastering, or as a composer of soundtracks for websites and advertisements, or in the film and videogame industries, as a producer for other artists or working as a live DJ, to name a few examples. It is not necessarily easier to earn a living in such careers, but it should be clear that diversified workplaces are potentially available for musicians with competence in technology.

Concluding discussion

By way of conclusion, it is helpful to first recall the context, specifically that these teachers (except Anders) were the first to ever teach laptop as an instrument at their respective schools and that there are likely to be similar situations elsewhere over the coming years. This ‘newness’ makes for an open, democratic and explorative teacher role whereby working on students’ musical creations is an integral part of the lessons. Thereby, the first challenge for teachers is to evaluate what is important to teach. With open curriculum goals and explorative learning, the content and didactic strategies are highly dependent on the background and teachers’ evaluation of important content to teach. The lessons are relatively less focused on using repertoire for covering existing music, unlike traditional instrument lessons. Still, the equivalent of ‘repertoire’ is used for other purposes: learning aesthetics for mixing, as a ‘reference’ for music creation/synthesis and as a stimulus providing ideas for live shows/setups. Laptop music students often also select songs associated with (rock) band classes, including covers for student concerts, and vocalists wishing to work with popular music. Laptop teachers use different approaches to teaching, either focusing on a single effect like compression or learning different skills when encountering productional challenges in a song.

The aspect of live performance is described as an issue by the teachers, as live looping and live sampling are skills that take a lot of time to practise, and mistakes have the possibility to greatly impact the entire live performance. Thereby most students take an easier route to live performance, activating playback and processing while sometimes playing a traditional instrument on top. In the findings, the teachers who used Ableton argued for how the program creates privilege on live performance through the loop-based session view. As Bell (2015) explains, the most accessible affordances of the technology used for music composition can shape the music created on a device. Bringing the laptop into music schools can lead to students composing more loop-based music, as this study shows through the example of the ‘live looping lesson’ (Magnus: Observation 2). Indeed, one can argue that, in Bell’s terms (2015, 2018), the ‘privileged’ affordances of Ableton – the most commonly used DAW (Øien, 2020) – have shaped music performances to become more loop-based. This becomes especially evident when one conducts a YouTube search for ‘live looping performance’. Using Google, the most popular search engine, where on the first page of search results (as of February 2023) over 50% of loop performances use Ableton Live as the primary device or DAW.

As shown in the three observations of laptop lessons, variation of teaching content in laptop lessons is highly diversified. As the first author observed, topics in lessons ranged from synthesis/sound design, to live looping and even to challenges when utilising laptop in a band of traditional instruments. Thus, considered in relation to the authors' personal experiences teaching lessons in trumpet and bass guitar, there is a relatively more diversified skillset taught in laptop lessons. This allows for a broader focus that includes more of a student's skills in composition and sound aesthetics that seen in traditional instrument lessons, blurring the lines between composition lessons and instrument lessons. This is consistent with the notion of 'affordances' (Withagen & Costall, 2021) and even 'extended cognition' associated with new technologies (Krueger, 2014) since working with the laptop enables teachers and students to approach music-making in entirely new ways. Still, noting that all observed teachers were the first to teach laptop at their respective institutions, laptop lessons are still at an early stage of development, and the pedagogy and teaching content of laptop as a musical instrument will most likely evolve even further over time.

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