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Interactive sound art and animated notation as an ensemble performance platform in primary level music education

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This article showcases excerpts of my artistic research in progress. In particular, I demonstrate how an interdisciplinary approach combining knowledge from the fields of artistic research, Human Computer Interaction (HCI) and game studies may inspire primary level music education of today. I highlight examples of novel digital music technology and present an innovative approach to using these for group performance exercises in the music classroom. In particular, I report from a study where my interactive sound art exhibition LINES, in combination with animated music notation, was used as a digital ensemble music platform. The data of the study comprises five workshop sessions with pre-schoolers using this platform. An autoethnographic method and analysis of video documentation of the workshop sessions were used as methods for the study. The results showed that LINES was both engaging and easily accessed. Moreover, it allowed the majority of the target group to perform musical exercises as an ensemble. I argue that the use of traditional instruments and traditional notation creates a democratic issue in primary level music education. Furthermore, with support from the study and related research, I argue that platforms such as this may democratize music education involving pupils aged 5-15 years.

Keywords: primary level music education, artistic research, ensemble performance, digital music technology, interdisciplinary

1. Introduction

In recent years digital technology has changed, and it continues to change, the way we consume, compose and perform music in society. Music education is, of course, no exception to the effects of this technology revolution. Digital tools are now seen as a relevant part of curriculums for music education globally. Previous research reports that use of technology may, for example, motivate student participation, provide forms of collaboration and promote creative activities (e.g. Karsenti & Fievez, 2013; Burnard, 2006, 2007). Göran Folkestad states that digital music technology has implied a “democratization of creative music making, in respect to, for example, social class, gender, generations, economic prerequisites, ethnicity and cultural backgrounds” (Folkestad, 2018). Andrew R. Brown defines three perspectives on how digital music technologies could be used within music education: as a musical tool, as a musical medium and as a musical instrument (Brown, 2014). Despite the potential of new digital music technology as pedagogical tool, medium and instrument researchers report on low usage within music education (Cuban, 2009; Somekh, 2008). The Swedish national evaluation report about music education in 6th to 9th grade shows that digital music technologies are not sufficiently implemented (Skolverket, 2015). Researchers in the United States report similar results, that is, digital tools are not used to their potential in music education (Taylor and Deal, 2000; Dorfman, 2008). Possible reasons for this issue are a lack of computers, inadequate technical support and insufficient professional development to acquire the pedagogical understanding necessary for effectively integrating technology (National Education Association, 2008). Supported by previous research, Marja-Leena Juntunen states, “in music education as in education in general we lack pedagogical approaches to use technology in a meaningful way” (Juntunen, 2018: 68). She continues by arguing that we need more research that showcases novel approaches on how to use digital music technology in music education. Earlier studies relate that digital technologies are mostly used as a tool and medium within music education (Skolverket, 2015). However, very few examples showcase the use of digital technology as a music instrument, especially when used within an ensemble or orchestra performance setting (I am not talking about digital instruments as, for example, synthesizer, electric guitar or digital drums here, since they use traditional interfaces to interact with and thus, for me, in this context are seen as traditional music instruments).

As a point of departure for this article, I argue that when using traditional instruments – for example, piano, guitar and drums – democratic issues are created, especially when used in ensemble performance in primary level music education. Within the article, I use primary level music education as a term to describe music education ranging from preschool to the ninth grade in Swedish elementary school (pupils aged 5-15 years). With support from my study, I will showcase a novel approach on how digital music technology may be used as an ensemble performance platform. My key argument for digital instrument interfaces, in comparison to traditional acoustic instruments, is the ability to make these both accessible for novices, regardless of their musical background, and still provide meaningful artistic musical expression. For the study, I involved a very young target group: five-year-old pre-schoolers. The ambition was to ascertain if, and to what extent, this young target group could perform musical exercises as an ensemble using the digital ensemble performance platform. The digital platform used within the study was my LINES interactive sound art installations and animated music notation, both of which have been developed within my artistic research. With support from the results of this study, I argue that digital music technology used with a suitable approach can be both an intuitive and expressive tool within primary level music education. Moreover, I highlight the interdisciplinary perspective, which was a part of the development process of the LINES interactive sound art installations and the dedicated animated music notation. More specifically, I highlight research findings from the fields of Human Computer Interaction (HCI), artistic research and game studies, which I argue may inspire and benefit the development of primary level music education in general.

Firstly, if we take a glance into the field of HCI, the huge amounts of technological alternatives available, such as various sensors, Arduino¹ boards and visual programming languages like Max/MSP², have made it possible to create novel musical controllers easy to use for novices, regardless of their age and musical background. One should keep in mind all the music instrument applications available for tablets, which could be both accessible and musically rewarding even for younger children. Within the field of HCI, as in conference proceedings of NIME³ (New Interfaces for Musical Expressions), numerous examples of novel interactive instruments are to be found, including my own contributions. Single player instruments meant for expert musicians have

¹ <https://www.arduino.cc> Arduino is an open source electronics platform open for anyone interested in making interactive projects.

² <https://cycling74.com> Max/MSP is an open source visual programming language.

³ <http://www.nime.org>

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historically made up the majority of the instruments designed to be used in the field of new interfaces of musical expression (Blaine et. al., 2003). However, through the years, projects have also been initiated by researchers, composers and musicians to develop multiplayer novel instruments accessible for novices. The reacTable , Jam-O-Drum and The Squeezables are examples of such multiplayer instruments, while other more recent examples include Hitmachine and Simpletones (Kaltenbrunner et. al., 2006; Blaine et. al., 2000, Weinberg et. al., 2001, Jakobsen et. al., 2016, Zamorano, 2012). Scholars argue that one of the main factors which makes an instrument intuitive and easy for novices to learn quickly is that the musical control is highly restricted (Blaine et. al., 2003). Indeed, as a consequence the limited musical control of the instruments may also result in a lack of musical depth or expressivity (Barraclough, 2015). However, there are examples of novel instruments developed within the artistic research or artistic practice field that are both accessible, musically rewarding and mobile, such as online web applications and downloadable applications for tablets. In the Biophilia Educational Project, artist Björk, in collaboration with the University of Iceland, developed a downloadable application for tablets to inspire children to explore their creativity through music and science⁴. The Biophilia application, which also comes with pedagogical exercises for school settings, is an example of an outcome as a pedagogical tool for music (and science) education generated through an interdisciplinary approach combining new technology with knowledge from the fields of artistic practice, natural science and education. Other examples of novel approaches using digital technology as music instruments is found in research by Australian researchers Andrew Brown and Steve Dillon. They explore the potential for using computers, linked via a network, as instruments for collaborative musical improvisation (Brown, Dillon, 2010). More similar examples include the Princeton Laptop Orchestra (PLOrK) (Trueman, 2007), the mobile phone orchestra at Stanford University (MoPhO)(Wang et.al, 2008) and the Ipad ensemble at the University of South Florida in Tampa (Williams, 2014). I argue that these examples are interesting as novel approaches using digital music technology as ensemble performance platforms. However, most of these examples are situated in higher education music studies.

In this article, my focus is to argue that similar approaches might be used in primary level music education in both group and whole class performance exercises. Even if novel musical interfaces or applications for tablets are easy to use for novices in a school setting, instructions and guidance on how and when to trigger the sounds in a performance are needed to perform music as an ensemble. I argue

⁴ <https://biophiliaeducational.org>

that traditional music notation is not the best pedagogical tool when working within primary level music education because it, similar to traditional instruments, requires the performers to have significant knowledge.

Secondly, within the field of artistic research, and more specifically the field of animated notation, we can find new approaches of accessible notation for novices. In recent years, artistic research has become an established field within academia (Hannula et. al, 2014). The artistic process often stands in the centre of the research; and as with other research, the aim is to develop and search for new knowledge for the field: the artistic field (Borgdorff, 2012). Animated music notation has recently become an emerging field among researchers and artists within the field of contemporary art music and can be seen as a development of the graphic scores composers such as Earl Brown⁵ and John Cage experimented with in the 1960s. As the name suggests, it could briefly be described as moving graphics presented on a screen to give performance instructions to a musical performer. Some advantages of animated music notation are, for example, its intuitive approach and the possibility to notate any type of sound source or non-traditional instrument (Fischer, 2015). Other terms – such as motion graphic notation (Fischer, 2013), real-time scores (Kim-Boyle, 2010, Wyse et. al., 2014), screen scores and dynamic scores (Hope et. al., 2010), which describe similar notation systems – can also be found in articles within the field. The composer and researcher Ryan Ross Smith has gathered information about animated music notation on the website www.animatednotation.com. Animated music notation found within the field of contemporary art music is most commonly used to give performance instructions to expert musicians in search of new and extended notation to develop new musical expression. However, as similar to the graphic scores a la John Cage, music teachers and scholars have argued that animated notation also may serve as accessible performance instructions to involve novices in musical interaction⁶. Icelandic composer Áki Ásgeirsson used animated notation as performance instructions involving more than a thousand nine-year-olds as performers for his composition 268° , which can be seen in a videoclip on YouTube⁷. There are also examples of using animated notation within music education. Shane Mckenna, researcher and music educator has created an animated music notation platform called Dabbledoomusic.com. On the website, he argues that his animated notation makes music education more accessible, engaging and fun both for teachers and students (Dabbledoomusic.com, 2019). The Dabbledoomusic platform provides musical exercises for

⁵ <https://graphicnotation.wordpress.com/tag/earl-brown/>

⁶ <https://www.teachingideas.co.uk/notation/graphic-notation>

⁷ <https://youtu.be/Kt0N3J9DLKc> (Videoclip of Áki Ásgeirsson, 268° live performance)

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preschool classes up to the 6th grade within primary school. By using animated graphics presented on a screen, a whole class can perform and accompany the music of videoclips, including both Irish folksongs, pop songs and classical music. Furthermore, the website states that the Dabbledoombusic platform, which includes animated notation, makes it easy for schools to cover all areas of the primary level music curriculum in a fun and accessible way.

Thirdly, I would like to highlight some concepts within the field of game studies. These have inspired my artistic research, and I believe they can also inspire primary level music education. In recent years, researchers and educators have discussed if videogames, or game elements found within these, might serve as pedagogical tools within education. Gamification is one example of a term that has been discussed within the field; it is defined as “the application of game elements in non-game settings” (Huang, 2013: 15). Within music education, scholars have argued that game elements can be used as a method to increase the level of motivation for music collaboration activities such as performances (Rolo, 2011). However, researchers also report on the importance of noting that games can be addictive, thereby having a negative influence on students, who can easily become addicted (Erenli, 2012). Furthermore, more research is suggested within the field as it is sometimes arguable if the gamification of education always increases the students’ learning results (DomiNguez, et. al, 2013). Popular music videogames such as Sing Star and Guitar Hero have been used within music education. Both teachers and scholars have argued that these types of videogames, through an appealing approach, may enable pupils to learn about and understand the elements of music (Gower et. al., 2012). The task of the Guitar Hero and Sing Star games is to sing or play certain famous pop/rock songs by following instructions that are presented as moving graphics. The gamers are rewarded with hi-scores that depend on how well they have performed in accordance with instructions. Within the field of game studies, concepts as *Flow* (Csíkszentmihálty, 1975), *The Magic Circle* (Juul, 2008) and *Immersion* (Kwastek, 2015) characterize efforts to deeply involve the gamers during game play; this is crucial for achieving a good result in the game. These concepts have influenced my artistic research and, more specifically, my work on animated notation to get performers, regardless their musical background, motivated and focused during a performance.

2. Background, Aim and Research Question

In my artistic research, I am exploring how novel interactive sound art installations in combination with animated music notation may involve novices, regardless musical background, in ensemble or orchestra performances of contemporary art music. To be clear, my artistic research in progress is not primarily about adding knowledge to the education field. It aims, as other artistic research, to search for and develop new knowledge to the artistic field: in my case, more specifically, the field of contemporary art music. However, in this article I will focus on a pedagogic perspective on my research findings and how these could inspire and benefit primary level music education. My research is interdisciplinary, mainly combining artistic research with HCI, game studies and aspects from the field of education. My work on novel interactive sound art installations has resulted in different exhibitions: at both Swedish and international venues. The ambition is often to engage both novices and professional composers and musicians in the same interfaces.

In the interactive sound art exhibition *Singing Instruments*⁸, first exhibited in 2013, I created three different instruments using everyday objects combined with sensors and technology. The instruments were created as multiplayer instruments to enable ensemble performances of musical textures commonly found in contemporary art music having people, regardless their musical background, as performers. In addition to the exhibitions, I organized workshop sessions with schoolchildren aged 10-12 years. Various musical exercises were performed with the schoolchildren using these *Singing Instruments* (Lind, Nylén, 2016). I am also developing novel instruments for digital platforms as tablets or mobile phones. My *MobilePhoneOrchestra.com*⁹ project, which is a work in progress, is another example of a music platform developed through an interdisciplinary approach, which could be suitable for music education. The platform is an online web application developed to enable performances of specially composed polyphonic contemporary art music for mobile phone orchestra. As similar to the *Singing Instruments*, people regardless of their musical background could participate in a mobile phone orchestra performance, which, if we talk about the democratic perspective, makes it very suitable for music education settings. The participants of a mobile phone orchestra use their mobile phones or tablets and perform on three specially developed music instruments provided online on the *MobilePhoneOrchestra.com* website. Unlike traditional instruments, such as piano, guitar or drums, I argue that these mobile phone orchestra instruments are very suitable for use in whole class settings regardless of the pupils' individual musical

⁸ <https://youtu.be/wLQ5Hs4GTeU> (Videoclip *Singing Instruments*, interactive sound art exhibition)

⁹ <https://youtu.be/z5LGOqmsZGA> (Videoclip of the *MobilePhoneOrchestra* platform)

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backgrounds. In use of my novel digital interfaces within music education, a comparison with Carl Orff's music instruments used in his exercises could be made. As similar to Orff's rhythmic instruments – for example tambourines, wood blocks, and so on – the MobilePhoneOrchestra platform is easy to use for novices. However, I argue that due to the use of technology within the MobilePhoneOrchestra-platform the musical expression is not limited to the acoustical restraints of an Orff instrument. Indeed, both types of instruments are, in my opinion, suited for use as ensemble instruments in primary level music education. However, I argue that the key is to use a proper approach regarding how to instruct schoolchildren on what and when to perform within an ensemble performance exercise. I use specially developed animated notation to give performance instructions for my novel digital interfaces.

My work with animated notation is inspired by theories from game studies and videogames such as Sing Star and Guitar Hero, which in their game design were using similar approaches to involve novices in musical interaction. Within a previous artistic research project, Voices of Umeå, I have developed an animated notation system titled the Max Maestro, which may involve non-professional performers using their voices as musical expression (Lind, 2016, Lind, 2018). In Everybody Scream!!!¹⁰, approximately two hundred citizens of Umeå of mixed ages used their voices to perform a contemporary art music composition in multiple parts conducted by the Max Maestro. Furthermore, I have continued in my research and artistic production to explore the possibilities of similar animated notation to give performance instructions to novices for performances of new contemporary art music compositions. Examples from my artistic production conducted by animated notation include Animated Notation for Mixed Orchestra¹¹, music for percussion orchestra (school pupils), professional chamber orchestra and electronics; Collectiveness¹², music for citizens, professional chamber orchestra and electronics; Twenty Twenty, music for mobile phone orchestra (school children) and professional chamber ensemble; and Uphonia¹³, music for mobile phone orchestra (school children) and professional sinfonietta. In my previous research and artistic production, I have involved mainly school children age 10-15 as performers in my work. In particular, the animated notation I have developed has shown to be very intuitive and accessible. Moreover, it has the ability to motivate novices as performers and, as a tool, provide me as a composer with new artistic expressions (Lind, 2018).

¹⁰ <https://youtu.be/VFebLXpe0fo> (Videoclip of Everybody Scream!!! live performance)

¹¹ <https://youtu.be/VXj4W2ihnUE> (Videoclip of Animated notation for mixed orchestra live performance)

¹² <https://youtu.be/OyMq13Uc6DY> (Videoclip of Collectiveness live performance)

¹³ <https://youtu.be/lX27q9MyqE> (Videoclip of Uphonia rehearsal session)

The aim of this research study was to explore how a very young target group may perform together using interactive sound art installations followed with instructions from animated notation. I was interested in determining if pre-schoolers as young as five could perform musical exercises together as an ensemble. My sound art exhibition LINES, together with animated notation developed for the LINES installations, was the focus of the study. More specifically, my ambition was to explore the limits of this LINES set-up by asking the following: If and to what extent could five-year-old pre-schoolers perform a music solo, or even in multiple parts as an ensemble, using the LINES – novel instruments conducted by dedicated animated music notation? In this article, the aim, with support from my research study and my ongoing artistic research, is to discuss some possibilities from an educational perspective. Moreover, I argue that an interdisciplinary approach combining knowledge from the fields of artistic research, HCI and game studies could be fruitful for today's music education.

3. Research Setting

3.1 LINES – Novel Interactive Sound Art



LINES – Interactive sound art exhibition (photo: Andreas Nilsson)

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LINES¹⁴ is an exhibition which I created in 2016 to explore lines as new interfaces for musical interaction. Lines – attached to the wall, on the floor and hanging from the ceiling, in combination with sensors and electronics – form three novel music instruments. The idea with LINES was to create instruments that were accessible and interesting both for novices – including small children – and for professional musicians and composers. The key factor was to focus on one fundamental musical parameter for each of the three instruments. From an artistic perspective, introducing constraints by delimiting control to one musical parameter was deemed likely to inspire and facilitate innovative use and result in new artistic expressions. From an educational perspective, the same limited control of the instruments could make them accessible for people, regardless of their age and musical backgrounds. The five colours – red, orange, blue, green and yellow – were used for the lines of the instruments, mainly to establish a playful and inviting approach, and particularly to simplify instructions on how to use them even for small children. The LINES instruments were created as multiplayer instruments but could also be explored by one single player. Two of the three LINES instruments were used in this study, mainly because the limited time of the workshop sessions was not enough to include all of them.



FIVE LINES instrument (photo: Anders Lind)

The Five Lines instrument was created for one to five performers. Pitch is the fundamental musical parameter the instrument explores; and by interacting in groups, different harmonic textures can be created and explored. The instrument consists of five vertical coloured lines attached to a wall, resembling a stave of the western notational system. At five spots, a white tube

¹⁴ <https://youtu.be/bP36xoPXDnM> (Videoclip LINES - interactive sound art exhibition)

is mounted on the wall beneath the lines. These five spots indicate where to interact with the lines. By placing a hand on or in between the lines, a sound is triggered. When moving the hand up or down, the pitch of the sound is changed. Recorded and pre-processed voice sounds were used for the instrument, and the pitch was organised in a major scale with a total range of a major tenth. The movements of the hands are picked up by five SHARP GP2Y0A02YK0F IR distance sensors mounted inside the five white tubes below the lines. The distance sensors are connected to an Arduino board, which is attached to a Mac mini-computer. The hand movements are translated into digital information and routed through a Maxuino bridge into a stand-alone application coded using the visual programming language Max/MSP. The Max/MSP application puts out the sounds through a M-AUDIO ProFire 2626 multichannel soundcard, enabling five separate audio outputs and a dedicated M-AUDIO BX5 D2 monitor speaker for each of the five performer spots.



TEN LINES instrument (photo: Anders Lind)

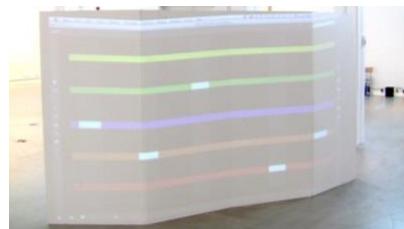
The Ten Lines instrument is created for one to ten performers. Tempo is the fundamental musical parameter to explore with the instrument; and by interacting in groups, various poly-tempo textures could be created and explored. The instrument consists of ten coloured lines attached to the floor. By walking or standing on the lines, sounds are created. When walking sideways along a line, the tempo of the sound is changed. Recorded and pre-processed sounds of drum machines and synthesisers were used for the instrument. The technical set-up of the Ten Lines instrument is similar to the Five Lines instrument, except for the use of ten SHARP GP2Y0A710K0F IR distance sensors and a M-AUDIO ProFire 610 soundcard.

3.2 LINES - Animated Notation

Dedicated animated notation was created for both the Five Lines and the Ten Lines instruments to give performance instructions to the pre-schoolers. The graphical design of the animated notation was created to resemble the graphical design of the instruments. The animated notation for the Five Lines was graphically designed as five coloured lines placed in horizontal positions, similar to the five lines instrument. When a white line appeared on or in between a line in the animated notation, the pre-schoolers were instructed to play on that specific spot on the instrument. If the white line appeared on a red line, the performer should play on the red line, and so on. The animated notation was slightly different when showing instructions for one, two or five individual parts. When showing five individual parts, five white lines were shown simultaneously; and the pre-schoolers were instructed to follow one specific white line only, which was decided for them in advance.

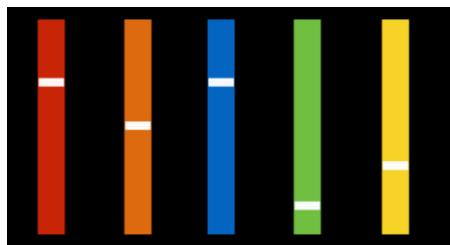


FIVE LINES – animated notation for one part



FIVE LINES - animated notation for five parts

The animated notation for the Ten Lines instrument was graphically designed as five coloured lines placed in vertical positions, as similar to the Ten Lines instrument. When a white line appeared on a line, the pre-schoolers were instructed to stand on the same coloured line on the instrument. The position of the white line on the coloured line indicated which position on the line of the instrument to stand on.



TEN LINES – animated notation for five parts

4. Research Method

My study was based on collected data from five workshop sessions including pre-schoolers and myself as a supervisor. Considering my double roles – both as a supervisor and as a researcher within the study – an autoethnographic approach was used as research method for the study (Schensul et. al., 1999). An autoethnographic approach draws a blurry line between external objective knowledge and personal, internal subjective knowledge, which suits my artistic research well (Ellingson, Ellis, 2008). I was aware of the fact that one's observations are filtered through one's interpretive frames; however, I intended to give objective observations as possible (DeWalt et. al., 2002). Nevertheless, my subjective experience of the workshops, which is affected by my embodied knowledge and previous experience as an artist and human being, was important for the study. The aim was to observe the sessions from an artistic perspective, more specifically, if and to what extent the target group of pre-schoolers could perform music using the LINES instruments conducted by animated music notation. Reflexive notes were taken directly after each workshop session to summarise my experiences of the workshops. As a complement to the reflexive notes, video recordings of the sessions were made, mainly to discover things that might have got lost during the live observations. The video camera was placed in the room to attract as little unwanted attention as possible from the pre-schoolers during the exercises within the sessions (Aarsand, 2009). According to good research practice, the parents of the pre-schoolers were informed of proceedings and had signed a consent document in advance (Hermerén, 2011). The document contained all required information about the study, including permission to make photo and video documentation during the sessions. However, I have chosen to de-characterize the pre-schoolers in the picture on page 18. The pictures on pages 9, 10 and 11 are press photos from the LINES exhibition, which I also have permission to use in research journal articles.

5. Workshop Structure

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The five workshop sessions were held for children from three different preschools. One or two teachers from each preschool were present and assisted to ensure the five different groups kept their concentration during the sessions. The five groups consisted of five to seven five-year-old pre-schoolers. The total time of the sessions varied from twenty to twenty-five minutes, depending on the time available, which was agreed with each preschool. From a researcher's point of view, the limited time for the workshops could be seen as a poor condition to obtain the necessary data for the study. However, I argued that, considering the age of the target group, short and effective sessions were preferable in order to maintain the concentration level of the participants. The sessions were held at a museum in a hall where my LINES exhibition was situated. Each workshop session included two interactive sound art instruments: FIVE LINES and TEN LINES. The animated music notation, which was also included in the workshops, was projected onto a temporary wall in the exhibition space so that everyone could see it. I used an Ipad to improvise the behaviour of the animated notation. The sessions were structured as follows:

1. Presentation/Introduction. Followed by short questions. – What is music? - What kind of musical instruments are there?
2. Testing the FIVE LINES instrument. All pre-schoolers got to test the instrument individually if they wanted.
3. Playing the FIVE LINES instrument solo conducted by ANIMATED NOTATION.
4. Playing the FIVE LINES instrument in pairs conducted by ANIMATED NOTATION in two individual parts.
5. Playing the FIVE LINES instrument all together conducted by ANIMATED NOTATION in five individual parts.
6. Testing the TEN LINES instrument. All pre-schoolers got to test the instrument individually if they wanted.
7. Playing the TEN LINES instrument all together conducted by ANIMATED NOTATION in five individual parts.

6. Results

My analysis of the video documentation and my reflexive notes of the workshop sessions showed that the exercises made were engaging for the participating pre-schoolers. Apart from one, all of the 30 pre-schoolers concentrated and participated in the exercises within the sessions, which, according to the teachers, was considered an accomplishment in itself. From a researcher's point of view, the limited time of each session consequently meant that some exercises were perhaps completed too quickly. Still, the collected amount of data was sufficient to obtain, in my opinion, interesting insights from the study.

The short introductory questions, which were meant to lead the pre-schoolers into the context of music and musical instruments, generated the following answers: To play an instrument or to sing was the spontaneous answer to what music is. Surprisingly, trumpet was the most frequently mentioned example of a musical instrument. Other instruments mentioned were piano, guitar, drums and flute. The questions led to the introduction of the FIVE LINES instrument.

Looking at the video documentation, it was clear that a majority of the pre-schoolers were thrilled to test the FIVE LINES instrument, while some of them were hesitant. My reflexive notes showed that all who tested the instrument were able to play and make sounds with it. The instrument was shown to be easy to understand and seemed to engage the participants. All of the pre-schoolers recognized and were familiar with the colours used for the instrument. Playful and enthusiastic reactions from the ones who interacted with the instrument and shouts like "Play on the green line" from the ones who were watching were heard on the video documentation. Since the sounds of the instrument were tuned in a major scale, the pre-schoolers could play notes within that scale by moving their hands on and in between the five lines. However, some of the pre-schoolers were not tall enough to reach the highest yellow line properly. Furthermore, their small hands needed to be stretched out in order for the sensor to read the accurate values. Moreover, it was not obvious to all of the pre-schoolers at this first encounter with the instrument that they needed to place their hand in the area above the sensors to be able to get sound.

The animated music notation for the FIVE LINES instrument was presented verbally, and my documentation showed that it was understandable for the participants. I was using an iPad to control the behaviour of the notation, which was projected onto a temporary wall placed on the opposite side of the FIVE LINES instrument. I considered this to be the best placement for the notation. However, it was still not satisfactory since the FIVE LINES instrument was placed on the opposite wall; and in order to see the animated notation, the performer had to change his/her

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view totally. A majority of the pre-schoolers wanted to test playing the FIVE LINES instrument conducted by the animated music notation, while some of them still wanted to just watch. First, they tested the exercise individually with just a solo part instruction from the animated notation. I was feeding the animated notation from the iPad with instructions to send to the pre-schoolers. The instructions included when to start and stop playing and which coloured line to play on. The video recording showed that all who tested the exercise were able to play on the instrument conducted by the animated music notation. Some understood immediately how to perform and could follow the notation when to change which line to play on and when to stop and so on, while some just tested playing on one or two colours. The video recording showed that the tricky part of the exercise was to maintain focus on what happened on the animated music notation while still performing on the instrument. As a consequence, the performance actions made by the pre-schoolers were sometimes slightly delayed, since it was hard to maintain a constant focus on what happened every second on the animated notation. Sometimes the sounds were too engaging for the pre-schoolers in the sense that they forgot to maintain focus on the animated notation.

In the next exercise, two pre-schoolers at a time were supposed to perform with the instrument, guided by two individual parts from the animated music notation. I was still feeding the animated notation with instructions to send to the pre-schoolers. Now the screen of the projection was divided in two similar parts of the animated notation, which provided individual instructions for the two performers. For instance, the animated notation could provide instructions for one of the performers to play on the red line and then give instructions to the other performer to play on the blue line, and then to instruct them both to stop at a certain point. By doing so, two different notes of harmonic sounds within the major scale could be created. The video recording and my reflexive notes showed that it now started to become more complicated for the participants. Still, approximately half of the pre-schoolers managed to perform on the FIVE LINES instrument in two individual parts generated by the animated music notation. The other half was either unable to perform at all in two individual parts or just barely. It seemed to be hard for the pre-schoolers to sort out the different information handed out to them and, at the same time, play on the instrument. Furthermore, some of the pre-schoolers seemed to be confused about which of the two individual parts of the animated notation to follow.

The final exercise with the FIVE LINES instrument included performing in five individual parts conducted by the animated music notation. All of the pre-schoolers, except for one child,

participated in this exercise, even the teachers. They all got one spot each of the FIVE LINES instrument; and in the cases where the session group included six or seven pre-schoolers, one or two children had to share one spot. The idea was to manage to play at least one harmonic chord with five different notes and then to make small changes in that chord. The groups in two of the five workshop sessions managed to perform this exercise as intended. The other three were either unable to play at all in five individual parts or just barely. My overall impression based on my reflexive notes was, as in previous exercises, that it was hard to maintain focus on the animated music notation and at the same time play the instrument as instructed. Moreover, the video recording also showed that it seemed too hard to keep track of their own individual part of the animated music notation when five parts were shown simultaneously. Still, all of the groups in the five workshop sessions were engaged with the exercise, and the video recording also revealed that the pre-schoolers were very excited to play on the instrument.

In the following exercise, the TEN LINES instrument was introduced. All of the pre-schoolers, except for one, who still just wanted to watch, were thrilled to test the TEN LINES instrument. Even those who were a little bit shy when the others were testing the FIVE LINES instrument, now tested this instrument. By standing and walking on the ten coloured lines on the floor, the pre-schoolers were able to get sound from the instrument. When standing on one line, the particular sound of that line was repeated in a steady pulse, which changed in tempo when walking sideways along that line. Some were content just to test one or two of the lines, while some tested the sounds of all the ten lines. The sounds of the instrument were short percussive sounds, which were organised in a C major scale. My reflexive notes in combination with the video recording showed that it was easy for the pre-schoolers to understand how to play the TEN LINES instrument. They seemed to find the exercise engaging and entertaining, both when performing on the instrument and when just waiting for their turn. However, to get sound, their thin legs needed to be put straight in the middle of the lines in order to be picked up by the sensors, which seemed a bit confusing for some of the participants at the first encounter with the instrument.

The final exercise within the workshop sessions was to play on the TEN LINES instrument in five individual parts conducted by the animated music notation. The animated notation for this instrument, which was similar to the notation for the FIVE LINES instrument, was first explained. Once again, the graphical interface of the animated music notation seemed to be easy to understand for the pre-schoolers. The animated notation was projected onto a temporary wall right beside the

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TEN LINES instrument. Moreover, the five to seven pre-schoolers within each workshop session were given one coloured line each to interact with following instructions from the animated notation. When a white spot occurred on one of the coloured lines in the animated notation, the performer of that line was meant to start playing a sound by standing on it. The intention with the exercise was to make musical structures in five individual parts by instructing the pre-schoolers to play on the lines at cues given by the animated notation: more specifically, to perform musical textures with the TEN LINES instrument, the unique instrumental characteristics of which would, as a consequence, result in musical textures where two or more tempi occur simultaneously, so called poly-tempo music.

In the first part of the exercise, the pre-schoolers were conducted to just trigger the start and stop points of the sound loop, by standing on or off the lines. If this part was executed as intended, a progression of the exercise was performed, where an additional instruction to modulate the tempo of the individual sounds by moving sideways along the lines was added. The video recording of the exercise showed that the groups within four of the five workshop sessions could perform in five individual parts on the TEN LINES instrument conducted by the animated notation, at least the first part of the exercise. The rhythmical structures created when interacting in multiple parts with the instrument seemed to engage the pre-schoolers, who at some points burst into spontaneous dance moves.

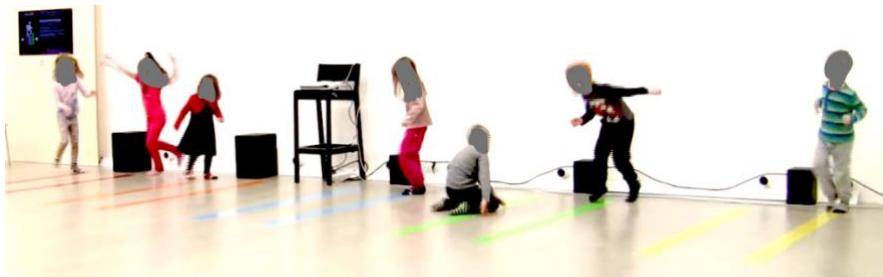
The second part of the exercise, which also included an additional instruction by the animated notation to modulate the tempo of the individual sounds, was performed with mixed results. Some of the pre-schoolers managed to follow these additional instructions, while the start and stop instructions were enough for some of them. However, performing with the TEN LINES instrument conducted by its animated notation seemed to be more intuitive and easier than performing with the FIVE LINES instrument and its animated notation. The differences were specially shown when the pre-schoolers were conducted to perform in multiple individual parts.

Based on the analysis of the observations, I argued that the differences were probably dependent on three main factors:

- The design of the graphical interfaces of the animated music notation. In the FIVE LINES set-up the performers seemed to be confused about which part to follow when the animated notation showed five individual parts, which not was the case in the TEN LINES

set-up. The TEN LINES notation seemed to be easier to follow, probably because the performers were given only one colour each to follow. In the FIVE LINES notation, the performers had the same five colours each to follow and the individual parts were not as clearly marked out as in the TEN LINES notation.

- Placement of the notation projection related to the placement of the instrument in the exhibition space. In the TEN LINES set-up, the performers could play with their feet and, at the same time, glance at the animated notation projected on the temporary wall located right beside the instrument. In the FIVE LINES set-up, the performers needed to switch their view back and forth, since the instrument was on one wall and the animated notation was projected on the other wall. This issue seemed to be too much to handle for most of the pre-schoolers in this study.
- The order of the exercises. Since the exercises with the TEN LINES instrument and its animated notation were performed after the ones with the FIVE LINES set-up, the pre-schoolers had already grasped the concept, which probably also had an effect on the result.



Workshop with pre-schoolers and TEN LINES instrument (photo: Anders Lind)

7. Discussion

The target group of this short study has been five-year-old using the LINES novel interactive sound art as music instruments performing together with instructions from animated music notation. The aim of this study has been to explore if and to what extent this young target group could perform

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ensemble exercises in this setting. My point of departure for the discussion is my argument that too much use of traditional instruments – for example, piano, guitar and drums – creates a democratic issue within primary level music education. Furthermore, I argue with support from my study that digital music technology could serve as complementary music instruments for ensemble performance exercises within the music classroom.

As researchers before me, I argue that digital music technology has the potential to democratize music education (Folkestad, 2018 et. al). However, the field is in need of new research that showcases novel approaches regarding how to use digital music technology (Juntunen, 2018). Specifically, I argue the field of education is in need of research on how to use digital music technology as music instruments in performance exercises. Similar to the ideas of Carl Orff (Tresher, 1964), I believe that children within primary level music education should be allowed to discover and explore music by themselves. The focus should be practical performance exercises in large groups using easy-to-play music instruments. Furthermore, these performance exercises should be musically rewarding, both in terms of music expression created and the possibility to perform within a diverse range of musical genres.

For me, “music is organized sound”, a term originally coined by the famous composer Edgar Varese. In my opinion, music is about how sounds are organized in various combinations, structures and layers, thus resulting in interesting outputs, not about how the sounds are produced. Indeed, the music instruments used to produce the sounds are important and, of course, reflecting the artistic output. However, if the sounds are produced by a professional violinist or by a child playing an electronic sound on a novel interactive instrument, as in this study, this would, of course, result in different artistic outputs, but the quality of the sound would not necessarily be better or worse. Once again, the music and the artistic output lies primarily in how the sounds are organized together. My point here is that I believe that in general when we talk about music in society, and in this case within music education, we tend to lay too much focus on the music instruments. Even in my short study, when asking the pre-schoolers what music is, their intuitive answers were all connected to music instruments.

Firstly, looking from a democratic perspective, the excessive focus on traditional music instruments does not harmonise with the ambition to include all pupils in music education. Indeed, traditional music instruments as piano, violin or guitar offer rich possibilities for musical expression. However, a quite high-level entry skill is needed to perform on a traditional instrument.

Thus, when the level of practical skills involved in a task is too high it, may not contribute to musical learning (Swanwick, 1999). As a consequence, pupils with no traditional instruments at home to practice on or with no previous experience taking instrument lessons have a hard time participating in these lessons. When focusing on traditional instruments, I argue that the main thing is about learning how the sounds are produced and to get physical skills similar to learning how to, for example, throw a javelin in sports. Furthermore, the aesthetics and artistic expressions and perspectives – which I believe are crucial to get an understanding of music – are left out.

Looking both at the fields of artistic research and HCI, there are several examples which music education could benefit from, when having the democratic perspective in mind. Novel interactive instruments – as my LINES instruments and MobilePhoneOrchestra.com, the previous mentioned The reacTable, Jam-O-Drum, The Squeezables, Hitmachine and Simpletones – are some examples from a democratic perspective of music instruments accessible for people, regardless of their age or musical background. Admittedly, a lot of these examples from the fields of artistic research and HCI are physically suited for exhibition spaces, and they would not in current design be able to practically fit into a traditional music education classroom. However, the ideas of these novel interactive instruments are, in my opinion, interesting for the music education field. Even if the study presented here is limited and needs more research to give secure claims, the results indicate that even five-year-old pre-schoolers could interact and participate in musical exercises as an ensemble using proper digital music technology. The key factor – which makes novel interactive instruments as LINES accessible, as opposed to, for example a piano or guitar – is the limited control the instruments offer a performer. By introducing constraints through delimiting the control of an instrument to one musical parameter, the instrument becomes very easy to use for first timers. When standing in front of a novel instrument with a low-entry skill needed from a performer, we are all the same, regardless our musical background in terms of knowledge of how to handle the instrument. The delimited control the instruments offer makes it easy to master how to physically perform on them. Thus, there is no need for hours of practicing, as with traditional instruments such as the guitar or the piano. Indeed, traditional percussive instruments as used in Orff's exercises, including claves, wood blocks or even hand claps, are easy to perform on for novices. However, due to their sound, which is connected to the acoustical restraints of the instruments' physical body, the musical expression becomes very limited. Furthermore, the limited expression of these percussive instruments offers mainly exploration of rhythmic material. By using technology as musical expression, the actual sound discharged from the instrument could be processed and mixed to

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guarantee a high- level artistic sound. Furthermore, the sound palette does not need to be restricted due to its physical body in a novel digital music instrument. Thus, the sounds can be in pitches, harmonic chords, percussive sounds, complex sound combinations, and so on. In other words, a novel digital music instruments can both be easy to perform on and provide a musically rewarding artistic output, which could enable exploration of various musical parameters. Using a novel digital music instrument as the LINES instruments in a primary level music educational setting would make it possible to directly get to the point of what, in my opinion, should be the core within music education. It should not concern how the sounds are produced. Rather the focus should be on the following: How are the sounds organized? What do they actual sound like? and why? However, more research is needed to determine possible short- and long-term consequences when implementing novel digital easy-to-perform instruments within primary level music education.

Furthermore, I argue that traditional instruments are deeply rooted in the musical context they appear in. Even before we start to make sounds on a traditional instrument, such as the electric guitar, we have many preconceptions and ambitions that are deeply rooted in the instrument itself and in the musical genres it usually appears in. Both the musical purposes an instrument was built for and how performers through history have formed a tradition on how to perform on an instrument affect what kind of musical genres we associate with an instrument. I argue that novel digital instruments and applications, unlike traditional instruments, have no routed traditions in terms of performance practice or what type of sounds and musical genre are associated with the instruments/ applications. The undefined musical history and expectations for these novel instruments and applications make them suitable for exploring a wide range of different musical genres. In this study, the LINES instruments were developed to enable performances of musical concepts, such as polytempic music, which are routed within the contemporary art music genre. Furthermore, the MobilePhoneOrchestra platform is another example developed as a contemporary art music platform suitable for use in music education. Like other scholars before me, I argue that musical concepts found within the field of contemporary art music have a lot to offer the music education (Siebert, 2017). Being able to perform contemporary art music and to combine practical and theoretical exercises within a whole class setting, could create an understanding of the elements of music. Various fundamental musical parameters as pitch, time, amplitude and timbre could be highlighted and discussed with an inviting approach by involving a whole class as a performance collective.

However, I have not, in my opinion, mentioned the most interesting aspect of these novel platforms from an educational perspective: the use of animated notation. As we know, the traditional score offers a

lot of possibilities to describe the attentions of a composer in terms of how various sounds should be produced and organized in multiple parts through a performance. However, similar to a traditional instrument, a lot of prior knowledge and musical experience is needed to firstly interpret and then secondly to even perform together following instructions from a traditional score and notation. Furthermore, a performance within an ensemble or orchestra setting would, in some cases, even demand a conductor to be able to synchronize the multiple parts. The use of animated notation combines both musical instructions in terms of notation for the performers and a tool to synchronize the performers in terms of a conductor in one concept. Animated notation has in my previous and ongoing artistic research showed to be accessible for performers, regardless musical background, and still provide an artistic expression suited for concert hall performances. The results from the short study reported in this article, including the LINES instruments, have now even shown that pre-schoolers as young as five-years of age could perform simple musical exercises together by following instructions from animated notation.

I argue that the key factor that makes my animated notation intuitive and accessible even for younger kids is how it is inspired and developed through an interdisciplinary approach and, more specifically, by implementing concepts generated within the field of game studies. I argue, as scholars before me, that the crucial issue for a pupil's ability to gain musical understanding or a performer's ability to succeed in a musical performance lies in the ability to get motivated and completely focused on the task. The concepts *Flow* (Csíkszentmihálty, 1975), *The magic circle* (Juul, 2008) and *Immersion* (Kwastek, 2015) found within the field of game studies have inspired the developing process of my animated notation. These concepts describe something every game designer or film maker are trying to deliver to their receivers, that is, a state of mind in which the outside world is forgotten and the narrative presented in the game or film becomes the truth. My work with animated notation has been developed with support from these game theories and, more specifically and concretely, by looking at how popular videogames as Sing Star and Guitar Hero are designed to motivate their target group. We all know that many videogames have an ability to attract a diverse audience especially among the young generation and to get their complete focus during gameplay.

My animated notation uses a similar approach, with animated graphics to present the performance instructions. The key is to get the pupils motivated by presenting a task that is reachable in terms of difficulty level. However, my animated notation does not give hi-scores to the performers dependent on their achievement. I argue that too much focus on hi-scores within the music education will turn the performances into a competition, and once again the focus will

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be on how the sounds should be produced and not on how are the sounds organized, what does it actually sound like and why? The musical output will be rewarding enough as a consequence of the pupil's ability to stay focused and follow the performance instructions handed by the animated notation.

I argue that my examples of animated notation could serve as tools to achieve performances in whole class settings within the music education. I argue that by mixing accessible practical and theoretical exercises that pupils, regardless their musical background, could take part in musical understanding could be achieved. The focus could then be on aesthetic and artistic perspectives more than physical perspectives on how to master an instrument or interpreting a traditional score. Indeed, my LINES animated notation and instruments reported here are not fully developed for an education environment. Still, the results from my study and other ongoing artistic research indicate that the ideas with animated notation and novel interactive sound art instruments/ applications could be used as complementary tools for traditional instruments and notation within primary level music education. However, further research within the domain is needed to give more certain claims.

8. Conclusion

This article has reported on an artistic research study focusing on five workshop sessions including pre-schoolers performing on LINES: two novel interactive sound art installations conducted by dedicated animated music notation. The ambition with this study has been to complement my previous research on interactive sound art installations and animated notation as tools for performance of contemporary art music. More specifically, it served to explore if children as young as five-years could perform music together within this platform. The results of the short study showed that the two LINES interactive instruments were engaging and easy for the pre-schoolers to understand. All of the pre-schoolers who tested the instruments managed to create sounds with them. The dedicated animated music notation created for the instruments also proved to be intuitive and easy to understand. Furthermore, the results showed that a majority of the pre-schoolers managed to perform solo using the instruments conducted by the animated notation. However, performing on the instruments in multiple parts, conducted by the animated notation, proved to be more difficult, and the results also differed between the two instrument set-ups. The design of the graphical interfaces of the animated notation, its placement in the room in relation to the instrument and the order of which instrument set-up was used first were analysed as the

main factors, which caused the differences. Nevertheless, four out of the five groups within the study managed to perform poly-tempo musical textures in five individual parts on the TEN LINES setup. Accordingly, this indicates that with proper interactive instruments and dedicated animated notation, fixed contemporary art music exercises in multiple parts for similar settings could be performed by children as young as five. With support from the results of the study, I have, in this article, argued that novel digital instruments in combination with animated notation could be accessible as pedagogical tools within primary level music education. I have especially highlighted the need to find new complementary instruments to the traditional music instruments, for example, piano, violin or drums. Furthermore, I have argued that the use of traditional instruments for ensemble performance creates a democratic issue in use within primary level music education. Indeed, novel instruments and animated notation need to be developed to fully fit into the music education environment, but I argue that examples from my and that of others within the fields of artistic research, HCI and game studies could serve as inspiration for the development of these novel instruments.

In conclusion, the study has clearly illustrated the potential of combining novel interactive sound art instruments with dedicated animated notation to include even pre-schoolers in performance exercises of music in multiple parts. This, and the limited scope of this study, indicates that further research in this domain is warranted. Numerous aspects warrant detailed investigation, but I specifically encourage future researchers to further examine novel interactive sound art and animated notation as pedagogical tools within primary level music education.

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