# Designing music lessons for the 21st century

Make learning a musical instrument more fun, playful, and modern

Bachelor Assignment
Creative Technology
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06/07/2018

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# Abstract

This study existed through an assignment of art school Kaliber. It looks at how to combine technology and music into a workshop. The goal of this study is to use modern technology to get children familiar with and excited about music creation through a workshop. The workshop will be given using a system consisting of four different MIDI instruments, each serving another function within the music: Drums, chords, melody and bass. The learning goal of the workshop that is being evaluated has been specified to learning how to identify and apply these functions. The ability to identify the instruments has been tested using a quiz with audio clips. The ability to apply the instruments is being tested by looking at improvements of the playing of participants from the beginning to the end of the workshop. To test whether the children were excited about the music making process a survey was handed out. The results indicate improvements in the identifying and the applying part, but these results are not enough to statistically proof that the workshop is better than traditional methods of teaching about this topic. However the results do indicate that it might be a good idea to do more research on this.

# Acknowledgements

I would like to thank my supervisor Marielle Stoelinga and critical observer Dennis Reidsma for helping me through the process of shaping this research. I would like to thank Frank van Nus for his help on developing the musical and educational parts of the system. I would like to thank Benno Spieker for his advice on the educational aspects of the system and for inviting me to present at the conservatory of Enschede. And finally I want to thank Janette Davelaar from Kaliber for giving the assignment and her help in providing the resources to come to the final result.

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# I - Introduction

This paper is made in collaboration with art school Kaliber. Kaliber is the biggest art school in Twente with seven different locations in the area of Overijssel. Kaliber teaches about a lot of different disciplines like dance, theater and music. Resulting in an offer of over 100 different cultural courses.

Kaliber is now trying to expand their education from traditional education methods to modern ways of teaching by incorporating technology into their lesson plans and hosting modern workshops. To host these modern workshops, Kaliber created a graduation assignment for a student to create such a workshop where technology is used to teach about music education. Which is the assignment being treated in this report.

Music education is a very broad topic, therefore it is necessary to specify this topic early on. It is possible to teach about theory, practical skills, listening, playing together, and much more. However I have been a part time guitar teacher for about four years and there is one topic I have always struggled with teaching. The topic of composition.

The problem with teaching composition is that it is way too abstract. There is no right and wrong and everything you teach is merely a suggestion or a guideline. According to Gann (2007), teaching composition is even ‘almost as much, or more, a process of emotional therapy than actual musical instruction’. Another problem is that the creation of music is often seen as “high art”, therefore seen as something only achievable by professional musicians (Toynbee, 2003, p. 102). Because of this, students are often not daring to write music themselves. However composing is a skill and the best way to learn this skill is to “just do it” (Maddocks, 2011). This results in a situation where a lot of people do not dare to start writing songs and therefore will never improve this skill.

This report will focus on finding a way of using modern technologies to get children familiar with and excited about music composition, with the goal to make them feel confident enough to actual start practicing the skill. Therefore the corresponding research question is:

- How can technology effectively be used to get students familiar with and excited about music creation?

Because this question is very broad, it will be split into the following three sub-questions for research purposes.

- How does the musical writing process look like?
- How is musical creativity stimulated?
- What is the effect of technology on music education?
- What are the benefits of joint music making?

Using literature, these sub questions will be answered individually. The results of these will be compared at the end of the paper to get an answer on the main research question. Using the answer provided by the literature, an idea for a workshop will be developed. This idea will serve as a hypothesis for the research question. The workshop will be carried out and evaluated with the intention to prove this hypothesis.

# II - Background

## 2.1 Explaining composition

In order to design a workshop about music composition, it is good to first take a look at what a song or composition actually is.

The cambridge dictionary defines a song as ‘a usually short piece of music with words that are sung’. In other words a song is a combination between two disciplines: poetry and music. When music teachers teach songwriting, they usually talk about only about the music part.

Music can usually be defined as a combination between harmony, melody and rhythm. A harmony is defined as ‘a pleasant musical sound made by different notes being played or sung at the same time [x]”. A harmony on its own is often called a chord. Melodies are a succession of notes that carry the main message of a song. Harmonies exist to make melodies sound interesting and add feeling to them. The rhythm determines the timing in which the harmony and melodie are played.

This is why songwriting is about finding the right combination between harmony, melody and rhythm. The amount of combinations between chords and melodies on its own can give infinite possibilities, but luckily our culture has specific combinations which are most often used and (therefore) sound more pleasing. For example, a song is usually written within a key, which limits the amount of notes/chords possible to choose from, from 12 to 7. But certain chord progressions are also more preferred and used than others.

An example to proof these common progressions is a study done by Carlton (2012). In this study the chord progressions of 1300 different songs were analysed. The results of this study clearly show that some chord combinations are more commonly used than others. Figure 2.1 shows which chords are mostly chosen after playing an e-minor in a song which is in the key of C major. It is very clear to see that it is wise to play an F major or an a minor chord afterwards.

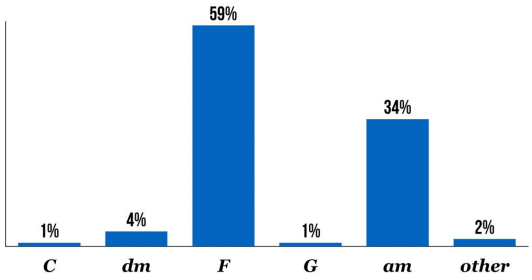



*Fig 2.1. Analysis of follow up chords after playing an e-minor chord in the key of C Major (http://www.hooktheory.com/blog/i-analyzed-the-chords-of-1300-popular-songs-for-patterns-this-is-what-i-found/)*

## 2.2 The musical writing process

In order to give a workshop about the writing of music, it is important to know what the process of writing music actually looks like.

A study about music composition in groups was performed by Biasuti (2012). Biasuti concluded that the musical writing process consists of different stages: Context definition, experimenting, constructing, playing and evaluating. In this process every phase is about the specification of previous ideas. For example, the experimenting phase is about trying out different things within the defined context (the theme/style of song), the constructing phase is about grouping the best parts into a logical structure and the playing and evaluating phases are about refining this initial structure.

Children use a very similar writing method. Burnard (2000) concluded that the type of composing, where the writing process starts with experimenting, is already incorporated into the writing process of children. From the study emerged that children use a lot of improvisation when composing. However, the underlying intentions of the children resulted in different ways of experiencing improvisation and composition. This relation can be divided in three categories. “Improvisation and composition as ends in themselves and differently orientated activities, Improvisation and composition as interrelated entities whereby improvisation is used in the service of making and performing a composition, and improvisation and composition as indistinguishable forms that are inseparable in intention (Burnard, 2000 p. 20).” The phenomenon that children experience different relations between improvising and composing can for example be seen in different music genres. Jazz music is for example all about improvisation and EDM is more about making the initial composition sound good by means of sound design.

Finally, the relation between composing and improvising is not only used by children or in groups. A study by I. Lawrence (as cited in Burnard, 2000) considers improvisation to be a ‘constant companion’ to the compositional process. Sessions (as cited in Burnard, 2000) describes composition as an ‘impulse which sets creation in motion’. Loane, Davies and Marsh (as cited in Burnard, 2000) regard improvisation and composition as two phenomena which are indistinguishably embedded in the one act of creation.

Biasuti and Burnard agree on the fact that in order to compose it is necessary to experiment. This method allows to first generate a lot of ideas to later on select the best one. This way of divergent and convergent thinking is commonly used in creative processes (Kaufman, 2012). However the type of relation between improvising and composing is not consistent.

## 2.3 Stimulating musical creativity

When teaching about music creation it is interesting to know how exactly creativity is being stimulated. This section will describe several ways to stimulate musical creativity.

The first way is to increase musical confidence. To identify social variables in the creative musical ability of children at the age of 10 and 11, Macdonald and Miell (2000) created

an experiment. In this study small groups were asked to compose a piece of music around a certain theme. The results indicated that groups consisting of friends were more creative than other groups. The reason for this was the lack of confidence of children without any music experience. The amount of confidence was a lot better when performing the assignment within the comfort of their  friends. This suggests that we need to explore further the link between children's ease of identifying themselves as 'musical' and their confidence to have a go at a task in the classroom (Macdonald & Miell, 2000). The article mentions the use of computers and the playing of recognizable pop music as ways to increase this confidence.

The second way is to focus on genuine experiences. The concept of identifying yourself as a musician to be better capable to compose music is also supported by Burnard (2000). According to Burnard our aim as music educators should be to facilitate a form of music education that focuses on genuine experiences of children being improvisers and composers rather than to act out a predefined model. Children should be encouraged to discuss what it is that is intrinsic to their own musical experience, identify themselves not only as music makers but as music creators, and be encouraged to reflect on what it is to improvise and compose.

Finally, age can be used as a way to stimulate creativity. According to Kiehn (2003) who did a study on the development of musical creativity of children in grades two, four and six there is a significant increase in musical creativity between grade two and four and no significant increase between four and six. This implies that children between seven and nine years old have a critical age when it comes to boosting creativity. A similar study performed by Brophy (1998) came to the same results. Brophy concluded that a "dynamic stage of development" might exist from ages six through nine, followed by a "developmental plateau" from ages nine through twelve. While this does not indicate that children between six and nine are the best age to target, since creativity does not linearly decrease with age (Rietzschel & Zacher , 2015). It does tell that it is possible to expect more creativity from children older than nine years old.

Macdonald and Miell agree with Burnard on the fact that in order to stimulate creativity it is necessary to take musical confidence into account. Children with less musical experience need to feel like they are a musician to be able to compose like one. This can be achieved by creating more recognisable tasks involving mainstream music and platforms like computers with which they are familiar. It is also interesting to consider which age to target. Children between the age of six and nine are in a rapid creative development so if the primary goal is to increase creativity it might be useful to target children in this age group, however if this increases the development even further has not yet been researched.

## 2.4 The effect of technology on music education

Before using technology as a tool to teach, it is important to look at its effects on music education. This section describes three of these effects.

The first effect is that students will become more independent. According to Way and Webb (2007) technology is responsible for the following changes in education: "A shift from instructivist to constructivist educational philosophies, a move from teacher-centred to student-centred learning activities, a shift from a focus on local resources to global resources and an increased complexity of tasks and use of multimodal information (Way and Webb, 2007,

p. 3).” From which can be derived that because of the growing use of technology, teachers should pay less attention on teaching actual information but more on how and where students can retrieve information themselves.

The second effect is the change in the content of music education. New music technologies enable musicians to engage with the ‘micro phenomena of musical sound itself’ (Théberge, 1997, p. 186). Now it is possible to precisely analyse and create sounds, the content of the music curriculum will change. “ICT can facilitate a shift of emphasis away from the traditional issues such as melody, rhythm or harmony to an increasing focus on dealing with the sound itself, thinking about its intrinsic value and place in a wider musical structure (Théberge, 1997, p. 186).”

The third effect is that teachers will have difficulty knowing more about technology then their students. While the developments in music technology bring a lot of new opportunities into the field of music education, not all music teachers are happy to incorporate these in their lesson plans. Results of research performed by Savage (2007) revealed that 50% of teachers has problems with incorporating technology into their lesson plans. In this study, teachers from 18 different schools were asked about their educational use of technology. They mainly had problems with the distractions technology provides and their own lack of knowledge on technology. “A number (39%) spoke of their pupils knowing more than they did about a particular piece of technology. This did not threaten the majority of the teachers (57% of this 39%), who saw it as a positive opportunity to encourage pupils to move towards a greater degree of independence in their learning (Savage, 2007).”

The development of technology will enable students to gather and learn information themselves. The task of the teacher will become to guide them into becoming more independent. All this while the content of information will shift from traditional theory, to thinking about sound in a much broader way.

## 2.5 Joint music making

One of the most common motivations to learn music is to be able to make music with others. Besides that it is a very fun activity to do, it also has scientifically proven benefits to it.

A study performed by Kirschner and Tomasello (2010) demonstrates this clearly. The study analysed and compared the behaviour of four year old children while making music with each other and when not making music. The study was able to prove that making joint music increases subsequent spontaneous cooperative and helpful behavior. A possible reason for this is the fact that when playing music, dancing or singing together, ‘participants keep a constant audiovisual representation of the collective intention and shared goal of vocalizing and moving together in time. thereby effectively satisfying the intrinsic human desire to share emotions, experiences and activities with others (Kirschner and Tomasello , 2010).’ This theory seems to be backed up by a study of Cirelli, Einarson and Trainor (2014). They were able to find a relation between bouncing on the beat of music and the helpfulness of infants of fourteen months old. ‘The findings support the hypothesis that interpersonal motor synchrony might be one key component of musical engagement that encourages social bonds among group members (Cirelli, Einarson and Trainor, 2014).’

Joint music making is not only beneficial to social skills but also to the general well being of a person. This is the conclusion of a research done by Burnard, P. and Dragovic, T. (2015). The study found that when when making music, people are both feeling engaged with a community, providing a family like experience and also can make people feel empowered because of the opportunity of being able to make decisions when for example improvising. ‘Thus satisfying the three basic psychological needs and features of well-being: autonomy, competence and relatedness.’

Making music with others enhances social skills and provides for the general well being of a person. While being one of the most fun activities within music and can therefore be argued as an essential part of music education.

# III - Ideation

## 3.1 Existing technologies

To gain appropriate knowledge about technical possibilities it is important to have a look at technology which is already out there.

### 3.1.1 Dato Duo

Dato Duo is a recent successfully funded kickstarter campaign, providing a tool to create and play with electronic music with two people at once (figure 3.1). Their vision: “We believe synthesizers are too much fun to be left to grown-ups alone. But existing synthesizers are often too complicated or precious to be used by kids. Also, jamming with each other is better than making music alone”. The Dato Duo consists of a loop machine for which the one person can control the notes. The other person can then play with effects and play a drumbeat underneath. The Dato Duo is a perfect tool to get people of all ages excited about sound design and electronic music. However, my opinion is that the machine focuses more on sound design than actual composition.


*Fig 3.1. Dato Duo (https://www.kickstarter.com/projects/datomusic/dato-duo)*

### 3.1.2 Hookpad

Hookpad is an online environment that provides tools to compose songs. It allows the user to create a chord progression by dragging and dropping chords onto a timeline and draw notes on top of them (figure 3.2). What makes the website specifically interesting is their so called “magic button”. When this button is pressed, the current chord progression is being analysed and a random chord is being given which will sound good after the current progression. Hookpad is a very useful tool if you want to create more complex melodies, but is in my opinion not very exciting if the user does not have any knowledge about music theory and composition yet.

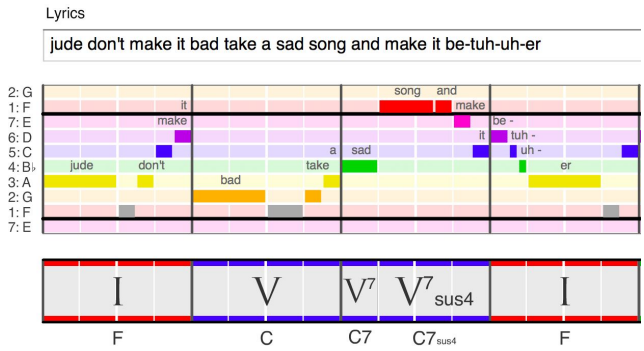



*Fig 3.2. Hookpad (https://www.hooktheory.com/support/hookpad)*

### 3.1.3 AI

Nowadays computers are already writing songs in the style of The Beatles (Flow Machines by Sony), writing music scores for entire orchestra's that are being used in movies and advertisements (Aiva), and are writing music that can be mistaken for music written by Bach (Murphy, 2015). While this already is fascinating, it becomes even more interesting when AI and the musician are working together.

#### Google AI Duet

Google has been developing a software that takes melodic input from the user via a keyboard and generates a response for that melody using artificial intelligence. The system has analysed a lot of melodies and using its neural net can find logical responses to the input of the user. The purpose of the system however is more about inspiration and fun than about actually providing a way to learn about composing. "It's just one example of how machine learning can inspire people to be creative in new ways." (Mann Y, 2017)

#### Alice

Alice is an AI created by an Australian startup called Popgun. Popgun created a system that can play along with the user. The system can listen to what the user is playing and can play notes on top of that which the system thinks are logical. My opinion is that the system does not encourage composing of chords, since this is what the user has to input, but can serve as a very good inspiration for writing melodies.

### 3.1.4 Current recording technologies

Nowadays, music can be recorded with just a laptop running DAW software and some type of MIDI input.

#### DAW

DAW stands for Digital Audio Workstation. It is an environment which allows the user to record , arrange and edit sound. Examples of popular DAW's are Ableton live (figure 3.4), Fruity Loops and Logic. What makes it so easy to record interesting music with this software is the use of virtual synthesizers and other virtual instruments. With just a MIDI signal it is for example possible to make it sound like you recorded a complete orchestra.

#### MIDI instruments

To be able to use  virtual instruments and virtual synthesizers, it is necessary to have some type of MIDI input. MIDI is a communication protocol for musical notes. MIDI contains information of for example pitch, velocity and vibrato. This either being transmitted using a MIDI keyboard, which is a keyboard which sends MIDI signals. Or a launchpad which is a grid of squares where every square is programmable to send a certain MIDI signal (figure 3.5).

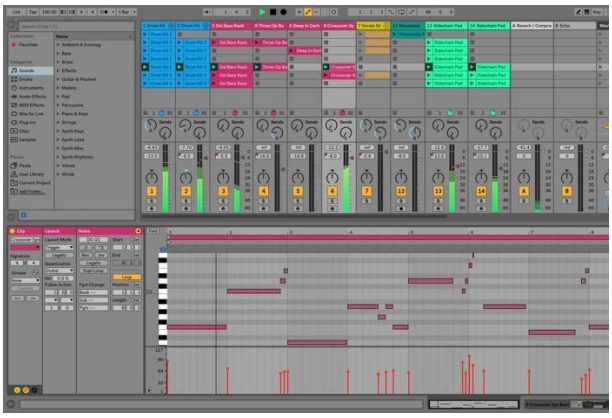


*Fig 3.4.  Ableton Live (https://www.sweetwater.com/store/detail/Live10Suite--ableton-live-10-suite-download)*

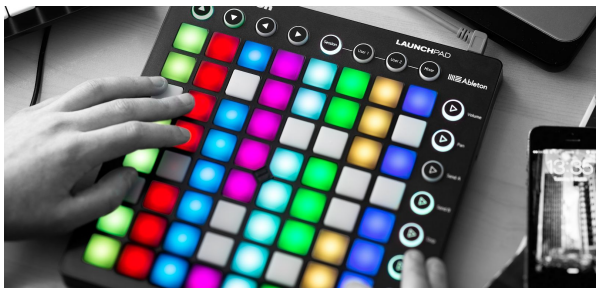



*Fig 3.5. Launchpad (https://global.novationmusic.com/launch/launchpad#)*

#### Samples

Next to sounds created by virtual instruments, modern music also often contains samples. Samples are small audio clips from other songs/audio recordings which are being edited to make new music with.

#### Synthesizers

Synthesizers are machines that are able to alter sound waves like sine and square waves into original sounds. Synthesizers are controlled using keyboard plugins. But can also be used in combination with for example sequencers.

#### Sequencer

A sequencer is a machine that repeats sounds in a certain sequence. In a sequencer it is possible to program sounds for each step. Sequencers are often used in combination with drum sounds. Such machines are called drum machines.

## 3.2 Functions of modern music instruments

When listening to modern electronic music, it is clear that most of the sounds do a lot of times not come from traditional band instruments like guitars and acoustic pianos, but more often from synthesizers. However the instruments within electronic music still serve the same purpose as instruments in any other western genre of music. Instruments can be given four different musical functions.

### 3.2.1 Melody

The melody of a song is the thing that the listener is most of the time actively listening to. Melodies are essentially a succession of singular notes. In pop music, the goal of a melody is to be able to be sung along to or to still be able to hum it the next day. This is why melodies are often repeated a lot within a pop song. Melodies of a song most of the time come from vocals. But in electronic music these often also come from synthesizers.

### 3.2.2 Chords

Chords are essentially a combination of notes played at the same time. They provide a structure for the melody. The most common chords in pop music consist of three notes, the root, the third and the fifth note. The third note within a chord is making it either minor or major. In western music chords are being played in a lot of different ways. For example, in classical music the chords can be played by a violin or horn section, in rock music it is the guitar/keyboard and in electronic music it are often synthesizers/pads.

### 3.2.3 Bass

In every type of music there is also an instrument playing some sort of bass. The bass provides for the lower frequencies of a song, thus creating the harmonic foundation. This is because of the way our ears and mind work. The lowest note out of all notes played at the same time is perceived as the main note that is being played.

A good example to illustrate this are the overtones of an instrument. When plucking the a-string of a guitar for example, the 440hz frequency is not the only tone that is playing.This is because a guitar does not sound like a sine wave. This is the result of the overtones. Overtones are frequencies which are octaves higher  from the original frequencies. The combination of the amplitudes of all overtones are shaping the sound of the instrument. But while so many frequencies are being played at the same time, the only tone that is being perceived is the 440hz one.
Bass can be played using a lot of different instruments but is always present in western music. In classical it is often a cello or trombone, in jazz a contrabass, in rock an electric bass and in electronic music often a synthesizer.

### 3.2.4 Drums

In almost every western song there is some kind of percussion going on. Drums are used to establish the rhythm of a song, making it easier to for example dance to it. The only difference between the drums in traditional pop and rock bands and electronic music is the more heavily processed sound of the drums. However the classification of drum sounds in all genres is exactly the same. For example, the kick/bass drum serves as an indication for the basis of the beat and is a very low, short sound. A snare is a more high pitched sound creating the accents of the sbeat. These two type of drum sounds form the basis of almost every type of music often accompanied by toms and cymbals.

## 3.3 Improvisation

Improvisation is the act of making music without planning anything beforehand. The most difficult thing about improvisation is to be able to know which notes sound right over which chords. To get started with improvisation it is an easy trick to start with the pentatonic scale. The pentatonic scale is a scale consisting of five notes where every note always sounds right over every chord within a key. This scale is often used in blues improvisation and rock guitar solos. A trick musicians use to create more melodic melodies is to accent the notes within the chord that is playing.

## 3.4 Hypothesis

While the literature research gave a lot of interesting insights, there were three points that were particularly interesting.

**Improvising phase**
It turns out that almost every compositional process starts out with an improvising phase. Meaning that when a musician is writing something he or she will not immediately start writing stuff down, but first starts with experimenting possibilities.

**Musical lack of self confidence**
Musical lack of self confidence is a big reason why musical creativity is limited. According to the articles, this lack of self confidence can be overcome by either working together with friends, or by making music with which the student is familiar. Which is often the modern (electronic) sounding music which is now in the pop charts.

**Playing music together**
Joint music making creates improvement in social skills and in the general well being of a person, while being of the most fun aspects of music.

When combining these three points it becomes clear that it might be a good idea to look into a system that allows multiple people at the same time to improvise in making modern sounding music. The Dato Duo is already doing a similar thing, however the Dato Duo focuses more on sound design and learning to work with sequencer rather than on composition. To find out if this concept can also be used as a way to teach about composition, the hypothesis of this research will be the following:

*A system that lets users improvise modern electronic music together is an effective way to teach about music composition.*

# IV - Specification

## 4.1 Requirements

Before designing the actual system it is smart to establish some requirements for this system.

### 4.1.1 Target group

Knowing what the target group of a product is, influences the design of the product. The target group for this system should be meeting the following two criteria.

**Age**
From literature research has been derived that the age at which the creativity has been developed is around nine years old. To fully enjoy the process of creating music, it is therefore a good idea to target children older than nine years old. However it is also smart to target children as young as possible, because the younger children are, the easier they learn a skill like composition. An age range from nine to twelve has been chosen as a target group to combine the best of both these arguments.

**Musical experience**
When targeting such a young age group it is best to assume that the amount of prior music experience is not that big. Therefore a requirement has been set that the system should be able to work with little to no prior music experience.
However people with already some musical experience would benefit more from learning and applying musical composition. Therefore the system has to be able to be engaging despite musical experience.

### 4.2.1 System

The system itself should meet the following criteria.

**Understandable**
Because the target group are young children the system can not be too complicated. The function of everything has to be either immediately understood or with very little explanation.

**Frustration**
The system should encourage people to make more music and should therefore not cause any frustration. Frustration can come from accidentally playing the wrong notes or just feeling like it is not possible to make anything that sounds good. Therefore the system should find a way to make it easy to play the right musical notes.

**Price**
Since Kaliber does not have unlimited resources, it is necessary that the product will not be too expensive. This means that it is not possible to make use of instruments like the Ableton Push.

**Modern music**
The musical lack of self confidence is reduced when people are making music they are actually familiar with. Lack of self confidence lowering the amount of creativity, like explained in chapter 2.3. This is why the system should make use of modern sounding music.

**Improvisation**
The system should allow the users to improvise. This is because improvisation is the first step to composing according to chapter 4.2.

**Technology**
The assignment given by Kaliber states that the workshop should be modern. This means incorporating modern technologies into the workshop. Therefore the system should make use of modern technology.

**Group**
Making music with other people has been proven to have a lot of positive benefits, besides from being fun. Therefore making it possible to interact with the system by multiple people at once should be a good idea.

## 4.2 Final idea

After a brainstorming session, several ideas have been created. Examples of these were:

- Using machine learning to analyse common music and use this knowledge to guide through the improvisation/composition process.
- A button which turns on a microphone on an instrument to record immediately when inspiration strikes.
- Give each member of a group a button, which triggers a certain drum sound, and let them create drum patterns together.

While these ideas sound nice, there was one idea that met all the requirements and is therefore the idea that is going to be developed during the rest of this study. The final idea for the system is to create four selfmade MIDI instruments with only five buttons each. The reason for this little buttons is the fact that often less choice increases creativity (Sellier L and Dahl D, 2011). The launchpad also has buttons to switch sounds and a knob to control the volume (figure 4.1). Every one of the four instruments is connected to a different category of music instrument, like mentioned in chapter 3.2. So every instrument either controls the chords, melody, bass or drum (figure 4.2). To make the improvising as melodic and easy as possible, the notes for the melody and for the bass adapt to the chords that are being played on the chord instrument (figure 4.3).

These MIDI instruments will be connected to a DAW where it will be possible to record the improvisation.


*Fig 4.1. The instrument*

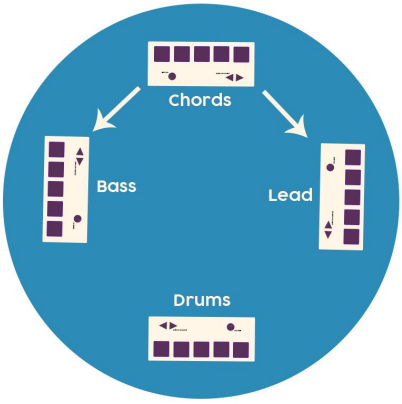



*Fig 4.2. The Setup*

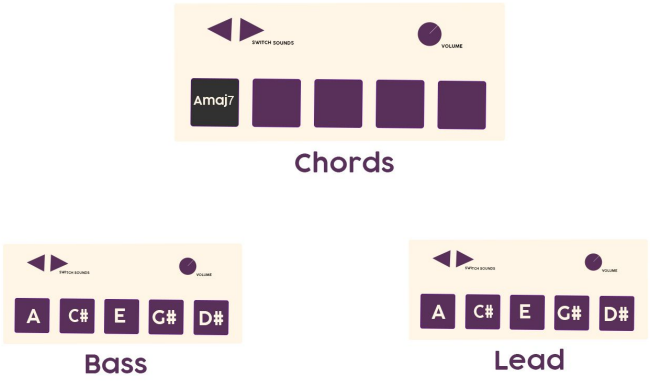



*Fig 4.3. Interaction explanation*

## 4.3 Structure of workshop

The main goal of creating this system is to teach people about music composition. This is being taught in the form of a workshop. After a meeting with Benno Spieker, who is doing a PhD on how to implement technology into music education, Spieker explained that in order to give a successful workshop it is necessary to focus on one specific thing to teach instead of trying to teach too much at once. Besides the benefit of getting participants excited about composition, this described design is expected to also have the following educational benefits that could be shaped into workshop.

### Improvising

To generate the initial musical ideas the participants have to improvise. The system makes the improvising really easy because it is impossible to play a wrong note. This allows the participants to immediately start crafting melodies in their improvisation.

### Listening

Because the notes are not indicating which notes they actually are, everything that is played and composed is being done by ear. This enhances the listening skills.

### Communicating

Because the launchpads affect each other it is necessary to communicate with other participants to get the bassline or melody you want.

In the end there has been chosen to focus the workshop on teaching about the different categories and functions of instruments and how to apply these into music. But also about letting participants experience making music together. Together with Frank van Nus, teacher of composition workshops at Kaliber, a lesson plan has been developed. The lesson plan can be viewed in Appendix A.

The overall structure of the workshop can be split up into three parts. The first part is to just let the participants of the workshop figure out how the system works and try everything out. The second part will be to discuss every single instrument in depth. Which will involve explaining what the function of each instrument is and how to apply it into music in a logical way. And finally, once it is clear what the instruments do, tell the children that they are now going to make their own song and record their improvisation.

# V - Realisation

The realisation can be split into three parts. The software which is making sure that the sensor input is being transformed into sound. The hardware which is about designing the cases and putting the right sensors in them. And the music theory which is about choosing the right notes for every button to make sure that the music always sounds right.

## 5.1 Software

The software is responsible for almost all functionality in the prototype. The software is responsible for the transformation of the raw data from the sensor into the right sounds. This is being achieved by three different programs (figure 5.1).


*Figure 5.1: From a pressed button to the right sound*

### Arduino

The code running on the arduino's is transforming the raw data from the capacitive sensors into information indicating whether a button is pressed or released. After this information is filtered, the data is being sent to the computer using serial communication There are four instruments, which means that there are four arduino's running an individual code, each sending data to the computer.The code for the arduino is visible in Appendix F.

### Processing

The rest of the programming is being done in Java using a work environment called Processing. The software is getting the information from Arduino on which button is being pressed and is linking this information to the right MIDI information and sending this to Ableton. When one of the buttons for changing the sound is being pressed, another virtual MIDI port is being selected which connected to a different sound within Ableton.

After the first user test it became clear that there had to be some kind of visual feedback displaying the counting of the beat. This is why also a display is being added showing the beat in counts of four, but also which instruments are playing which note. Adding a display was very convenient, since the laptop now has a clear function within the workshop environment. A picture of the display is shown in figure 5.2. The full code can be found in Appendix G.

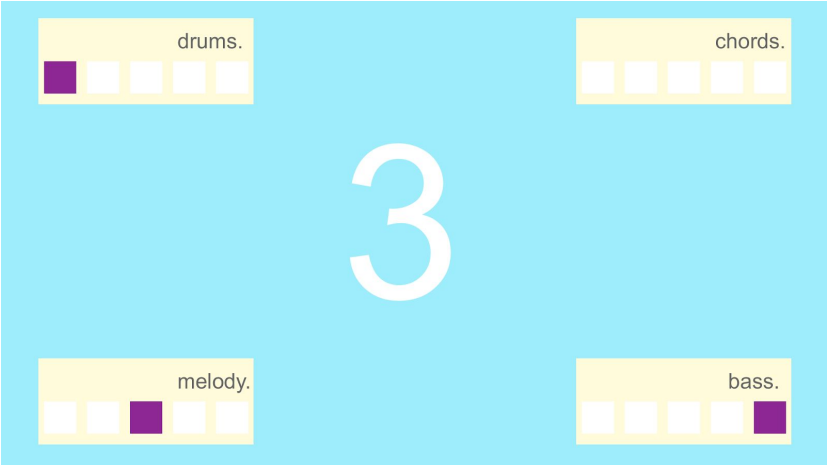



*Figure 5.2: Display of beat and instruments*

### loopMIDI

LoopMIDI is essentially the bridge between Java and Ableton. It is a free program that creates virtual MIDI ports. The program makes Ableton think that there is a MIDI instrument connected and allows Java to send MIDI data through there.

### Ableton

Ableton is the Digital Audio Workstation that is being used in this setup. The function of Ableton within the setup is to receive the MIDI data and transform this into sound using virtual instruments.

*Choosing the sounds*

There is a broad range of different instrument presets from which it is possible to choose from within Ableton, which all have even more possibilities to be altered. Besides the factory instruments from Ableton it is also possible to download additional, more professional and expensive, virtual instruments like for example Kontakt from Native Instruments. The main difference between the built-in plugins of Ableton and virtual instrument packages like Kontakt is that Kontakt uses samples and Ableton uses synthesizers. Meaning that sounds from Ableton have more possibilities to be changed and take up less space on the hard drive, while programs like Kontakt provide more high quality sounds. For the building of this prototype has been chosen to go with a mixture of these sounds to give the user the experience of both, providing a more broad soundscape. To switch the sounds of the instrument, the MIDI port is going to be switched. In Ableton every sound is going to be connected to a specific port making it possible to switch between them. In figure 5.3, four sounds for the chords are being shown.


*Figure 5.3: Four different chord sounds*

*Distinction between instruments*

The main goal of the system is to make people aware of the different functions of instruments. Therefore it is important to create a distinct difference between every instrument. One method to do this is assign notes appropriate register. Where the notes for the melody are on the high register, the notes for the bass on the low, and the chords in between them. Another important way to make this distinction is the make use of equalizers. What an equalizer does is that it can amplify certain frequencies and cut out other frequencies making sure that frequencies of for example the chords and the bass don't overlap each other. An example of how this equalizer is being used for the bass can be seen in figure 5.4. In this a bit extreme equalizer set up all the high frequencies are being cut out, allowing only the low ones to pass through. For the melody this will be done in the opposite way allowing only high frequencies to pass through. For the chords all the frequencies in the middle register will be highlighted. Drums are easier to distinguish from the other instruments since they don't evolve any tonality, therefore the equalizer for this instrument is not necessary.


*Figure 5.4: Equalizer of the bass*

## 5.2 Hardware

The electronics of the MIDI instruments are pretty straight forward. Every instrument consists of five big buttons to trigger the notes and two smaller ones to change the sound. The initial technology to sense if the button has been pressed was using push buttons like shown in figure 5.5. These buttons can either give a high signal or a low signal depending on whether the user is pressing them. The reason for choosing this approach was that it would leave room to put LEDs underneath the plexiglass buttons. All buttons are connected to an arduino nano which is then being connected to the laptop running the software.

During the realisation the decision has been made to get rid of the volume knob. The main reason for this is that the added value is not that big and that the music will probably even sound better when the volumes are correctly balanced, which without the volume knobs can be done beforehand.

*Fig. 5.5: pushbuttons (https://solarbotics.com/product/17392/)*

For the prototype a casing has been made using a laser cutter and plywood. The buttons have also been lasercutted but using engraved plexiglass. These plexiglass buttons are then being glued on top of the pushbuttons. The final prototype using these pushbuttons is shown in figure 5.6.

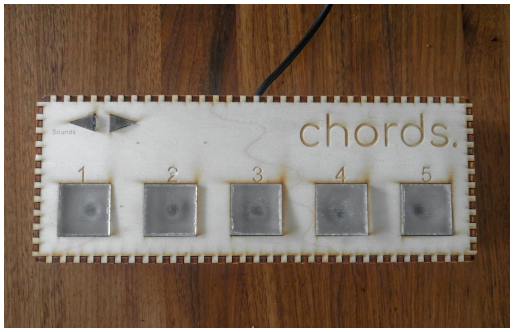



*Fig. 5.6: prototype using pushbuttons*

However during user testing it became clear that the push buttons were not reliable enough. The buttons would get stuck or not respond accurately, which caused a lot of frustration during the first user test. Therefore another method of sensing has been chosen for the final prototype, which is capacitive sensing. Capacitive sensing is sensing a capacitance that is existing from the combination of a piece of metal connected to the circuit and a person, who is connected to the actual ground, making it possible to sense how close a person is to the metal, or just to sense if the person is touching the metal. In figure 5.7 a capacitive sensor circuit is shown. Which will result in the buttons being made from some kind of metal. This metal will be created by sawing squares out of an aluminium plate. In figure 5.8 the final instruments are shown.

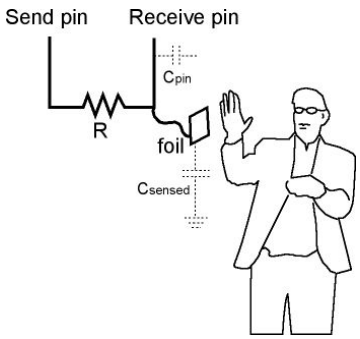



*Figure 5.7: capacitive sensor circuit (http://playground.arduino.cc/Main/CapacitiveSensor)*

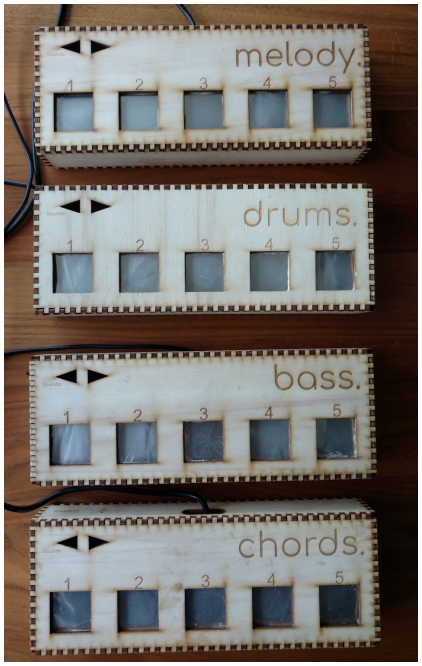



*Figure 5.8: Instruments using capacitive sensing*

## 5.3 Music theory

Another important part of the realisation of the prototype is the determination of the musical notes and sounds to be played. The first thing to determine is which key to play in. The decision went to the key of C major since this is the most common and easy one. Together with help from Frank van Nus, teacher of composition workshops at Kaliber, the following decisions have been made for the instruments.

### Chords

The five most common chords within a key have been chosen for the chord instrument. The I, III, IV, V and VI chords. Within the key of C major these become the C major,  e minor, F major, G major and a minor chords. With these five chords it is possible to play almost all the common

chord progressions in pop music like for example the infamous ‘four chord song’, which consists of the chords I - V - VI - IV.

### Melody

Finding the right notes for the melody was not as straightforward as finding the chords. Options were to just use the C major pentatonic scale, to use the pentatonic scale relative to the key that is playing or to just use the 3 notes within the chord that is playing with octaves. In the end the pentatonic scale relative to the chord that is playing turned out to be the most versatile and melodic approach. The actual notes relative to the chords can be found in table 1.

### Bass

For the chords C major and F major the 1, 3, 5, 6 and 7flat of both chords have been chosen for the bass notes. For the other chords the notes 1, 3, 5, 6 and 7 are used. Providing the notes for dominant 7 and minor 7 chords, making it possible to create the iconic blues riff by going up the notes and back. However for most pop music the bass is almost never playing notes other than the first, third or fifth note of the chord, so the two most right buttons are not expected to be used much. The actual notes relative to every chord are visible in table 2.

### Drum

The drums will provide 5 drum loops from which the user can choose. The first loop is just kick drum on the first and third beat. The second button is the same kick but now with a snare on the second and fourth beat. The third button is the same but with a high hat every eight beat. The fourth button is the kick drum together with a snare playing every fourth beat. The fifth button is the same kick with the snare on every eight beat. The loops have been chosen to make it possible to play with the dynamics of the song using the drum loops. The fourth and fifth button provide means to play the classic snare buildup which is hearable in in almost every dance track.

| **Melody** | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| C major | c | d | e | g | a |
| e minor | e | g | a | b | d |
| F major | f | g | a | c | d |
| G major | g | a | b | e | f |
| a minor | a | c | d | e | g |

*Table 1:Melody notes per chord per button*

| **Bass** | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| C major | c | e | g | a | b ♭ |
| e minor | e | g | b | c | d |
| F major | f | a | c | d | f ♭ |
| G major | g | b | d | e | f |
| a minor | a | c | e | f | g |

*Table 2: Bass notes per chord per button*

# VI - Evaluation

## 6.1 User testing

To make sure that the system is behaving as expected and there are no flaws that need to be fixed, the system will first be put to a few user tests. During these user tests the lesson plan will be followed and be checked on improvements. In total there have been two user tests one of them with non-musical family members (user test 1) and one of them with drum students at Kaliber of around 12 years old (user test 2). After the second user test a small survey has been handed out with a few basic questions about the what has been taught and a few questions about how they experienced the workshop and what could be improved. This survey can be viewed in appendix B.

### 6.1.1 Results

#### User test 1

The first user test was going chaotic. During the part of the workshop where the instruments were explained and everybody should have been paying attention, people were too distracted by making noise on their own instrument. However this is probably due to the lack of authority I have over my family members.
Another thing that was becoming clear during this session was the fact that counting to four on the beat of the drums is hard for people who have less experience in music. This became the reason why a program has been written to display this counting to four on the screen of the laptop. After this user test, also lines of codes were added to turn individual instruments on and off, so when explaining a specific instrument, other people could not interfere with theirs.

#### User test 2

After the second user test it became clear that push buttons are not the way to go for these instruments. The buttons on some of the instruments got stuck, making the whole process of making actual music really frustrating. Despite this frustration the workshop wasn't unsuccessful. The workshop was way less chaotic and the children could keep a rhythm (which might be because of the fact that they were drum students). From the surveys it became clear that they remembered what was talked about and that they enjoyed the process of playing with these instruments.

### 6.1.2 Displaying at presentation of conservatory

The system also has been presented at a demo day at the conservatory of Enschede. Students of the music teacher study had to design a way to incorporate technology into the classroom.

The purpose of this day was for the students to present what they had made. Because this project is very similar to those projects, this one could also be presented there.

Letting students who study to become music teacher try out the system and talking with them afterwards gave a lot of interesting insights in the pedagogical aspects of this system. Some very helpful tips about the structure of the workshop have been retrieved from this, which have been implemented in the lesson plan. One of them was to make the participants aware of the rhythm of the music early on.

## 6.2 Testing

### 6.2.1 Hypothesis

Now that the prototype is finished it is important to test if it actually has benefit for teaching composition. Earlier in the report has been stated that the hypothesis for this project is the following:

*A system that lets users improvise modern electronic music together is an effective way to teach about music composition.*

However after diverging the concept of composition to learning about different instruments and how to apply these in music, this hypothesis has been slightly changed. Firstly the hypothesis can be split into two different hypotheses. One about the ability to identify the different kind of instruments and the other about being able to apply these instruments.

For both hypotheses it is being expected that if participants use the system they learn more about this topic than when the theory will be explained without the system. However it could be the case that just explaining the theory could have the same effect. Therefore the hypotheses that are going to be tested are the following:

**Identifying the instruments**
$H_0$ = The workshop has no benefit over traditional teaching methods when it comes to identifying different functions of musical instruments.
$H_a$ = When users follow the workshop they learn more about different functions of musical instruments.

**Applying the instruments**
$H_0$ = The workshop has no benefit over traditional teaching methods when it comes to learning how to apply different kinds of musical instruments.
$H_a$ = When users follow the workshop they learn more about how to apply different types of musical instruments

### 6.2.2 Test design

#### Hypothesis 1: Identifying the instruments

The best way to test if a person can identify a certain sound is by actually playing this sound. Therefore the testing of how well the participants are able to identify different types will be done by letting the participants listen to different audio clips of instruments playing and asking them whether the function of this instrument is bass, melody, chord or drum.

For this test three small “songs” have been produced in Ableton consisting of four layers of music instruments (bass, chords, melody, drums). Every layer of these songs will be played individually where the participant has to guess which instrument it is. Afterwards all parts will be played at the same time to put the parts in their context. The sounds for the quiz can be found on www.robinvansoelen.com/musictest.

*Testing procedure*

The group of test volunteers will be split into two different subgroups. One group will follow the original workshop and make the music test afterwards. The other group will be explained the same theory as which is being explained in the original workshop but without the possibility to use the MIDI instruments. The lesson plan to explain the theory to the second group can be viewed in Appendix C. Both subgroups will get the same test. If the group which had followed the workshop scores significantly better on the test, the hypothesis that the workshop helps identify the functions of different instruments is proven.

*Analysis*

To determine if there is a difference between the two groups some statistical analysis needs to be performed. This can be done by performing an independent t test on the mean of both groups. The mean can be determined by the amount of questions correct out of ten. To make this test more powerful it is important to generate a large enough sample size to compare the two. This why the goal is to find a sample size for both groups of around 10 to 30 participants.

#### Hypothesis 2: Application of musical instruments

Designing a test to see if the workshop helps with applying the different instruments is a bit harder. This is because music is very subjective. Therefore how well somebody is able to apply these instruments is too.

A solution to this problem is to compare improvement of individuals rather than compare how well different people contrary to each other are doing. It is possible to measure this improvement by recording the first improvisation of the workshop and compare it with the recorded last improvisation of the workshop. How to identify these improvements is again something difficult. It is still possible to identify if people applied the functions of the instruments

which were explained during the workshop into their improvising. For example if the bass is playing accents on the root note of every chord. Or if the chords are not switching every second but are being played for a longer period, creating the harmonic structure.

Some people might argue that measuring the improvement at the beginning and at the end of the workshop correlates to the time spent on the system and not to the actual quality of the workshop. However even if this is the case, if the goal of the workshop is already reached by interacting with the system without any workshop, this can be seen as just as positive.

*Analysis*
Whether the workshop helped improve the skill to apply instruments is hard to prove in a statistical way. This is because it is not possible to use a reference group and therefore not possible to use any valid statistical test. It is not possible to measure the ability of applying the musical instruments on another group because the only other way to measure application of instruments is when the participants play actual musical instruments, however the target group is not limited to people who play an instrument.

Therefore the improvement has to somehow be measured on its own. It is possible to do this by analyzing the MIDI information of each instrument played. During the workshop some instructions are given on how to effectively play one of the instruments.

Per instrument it is possible to look at the corresponding MIDI information, from the shapes of this information it is possible to determine how much the participant has improved by using the system. But before this is possible it is necessary to determine what can be seen as improvement. The goal of the workshop is to identify the different functions of instruments and apply them effectively. Therefore every instrument has to be applied in a different way. Below the desirable outcomes of every instrument are explained.

**Drums**
The focus of the drums is to create dynamic differences in the music. One way to accomplish this is playing the fourth and fifth button after each other and going back to one of the first three. This way the classic snare buildup and drop is recreated which is hearable in a lot of modern music. How such buildup and drop would look like in MIDI is shown in figure 6.1. In this figure it is possible to see the note for the snare being doubled and then being released into a simpler drum groove. Besides dynamic awareness, it is also good to check the “messiness” of the music playing. Meaning that it is for drums not desirable to switch every second of drums loop, but rather to switch every eight or four measures.

*Figure 6.1: snare buildup and drop*

**Bass**
For the bass it is also important that not too many notes are being played at the same time. Since the bass provides the harmonic foundation of a song, this foundation would get unstable if the notes change every multiple times per second. This foundation also gets a lot stronger when the bass is playing the root or the fifth note of the chord that is playing, which are the most left and middle note on the instrument.

**Chords**
The chords bring the structure in the song. It is therefore also important that the chords played are structured. This means that again they should not change every millisecond but that they should  be dragged out for a longer period. A desirable chord scheme also makes use of some kind of repetition.

**Melody**
The notes of the melody can change quicker than once a second. It is useful to look for repetition however, since repetition makes sure a melody becomes more memorable.

## Survey

To get some ideas on how the workshop actually was experienced, a survey has been created. This survey consists out of questions based on how well everything worked, if they would like to continue with the instruments some other time, if they found the topic interesting and some other questions. Including some blank space to leave additional tips/comments.

The problem with these kind of questions is that the participants might be biased because they already have my face connected to the workshop and afterwards might not want to hurt my feelings by leaving negative comments. This is why most questions are phrased in a way that they have to talk about themselves instead of me. For example the question, “Was the workshop interesting?” can be phrased into the question, “did *you* find the workshop interesting?”. However this might still not be the most academic way to prove the workshop was a success, it might yield some interesting results.

### 6.2.3 Execution

The described test will be executed at BSO de Schatkist and BSO de Harlekijn. During the course of three afternoons, in total five workshops will be given. The age of the participants during these workshops will range from seven to twelve years old. This includes children who are a bit younger than the established target age. This is due to the fact that the amount of children older than nine is too low at the schoolcares.

# VII - Results

## Quiz

In table 7.1 the results of the quiz have been shown. The numbers represent the amount of right questions out of ten. In table 7.2 the mean and standard deviation of these results are shown.

| Before workshop | After workshop |
|---:|---:|
| 7 | 6 |
| 5 | 6 |
| 8 | 7 |
| 5 | 4 |
| 10 | 10 |
| 6 | 6 |
| 6 | 7 |
| 7 | 9 |
| 4 | 10 |
| | 6 |
| | 10 |

*Table 7.1: results of quiz*

| | ***Before workshop*** | ***After workshop*** |
|---|---:|---:|
| Mean (m) | *6.44* | *7.36* |
| Sample variance (s) | 3.28 | 4.25 |

*Table 7.2: mean and variance*

When using the information from table 7.2 two and filling this in into formula 7.1, this results in a t-value of 1,06. Since the goal of the experiment is to prove that the workshop makes the student perform better, it is a one sided test. When looking the corresponding value in a t table for ($n_a$ + $n_b$ - 2) 18 degrees of freedom, the null hypothesis can be rejected with a confidence of 85%.

$$t = \frac{m_a - m_b}{\sqrt{\frac{s^2}{n_b} + \frac{s^2}{n_b}}}$$

- a and b represent the two groups to compare.
- $m_a$ and $m_b$ represent the means of groups a and b
- $n_a$ and $n_b$ represent the sizes of group A and B, respectively.

*Formula 7.1: calculation of t-test statistic value*

# Music analyzation

Below the MIDI information of each instrument is shown at the beginning of a workshop and at the end of the workshop for three different sessions.

## Workshop one

**Drums**

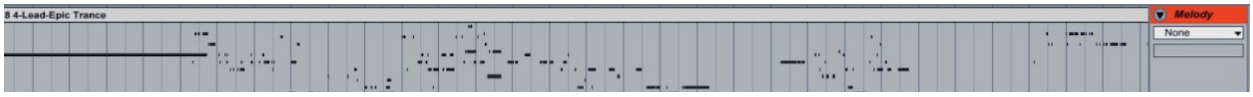
Before


After


The drums were at the beginning of the workshop already stable. However at the end the participant improved the dynamic part by incorporating one of the snare buildups.

**Melody**

Before



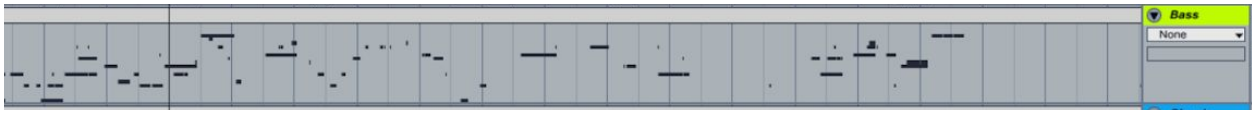

After


At the beginning the melody was really messy, this has improved a bit, however there is no sign of repetition noticeable.

**Bass**

Before

After




At the beginning of the workshop the participant was playing a lot of different notes fast after each other. This has reduced a lot near the end of the workshop.

**Chords**

Before


After

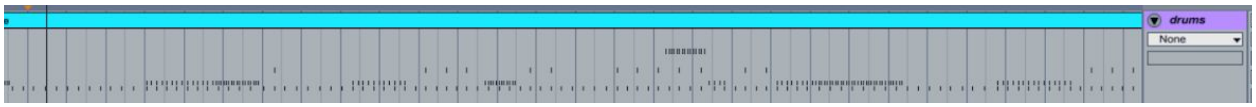

The chords have improved a lot. At the beginning there were a lot of different notes without any structure are being played. At the end of the workshop there is a clear sequence of chords, all played at about the same length.

## Workshop two

**Drums**

Before


After




It is clear that the use of drum loops has been improved over the workshop. This is notable because of the use of the snare buildup loops at the end of the starting session. Here the two snare build up loops are being dragged out for a very long time without actually resolving in anything.

**Melody**

Before

After


There is no clear improvement for the melody in both sessions.

**Bass**

Before


After


The notes for the bass have become much cleaner. The bass has also started implementing some repetition.

**Chords**

Before

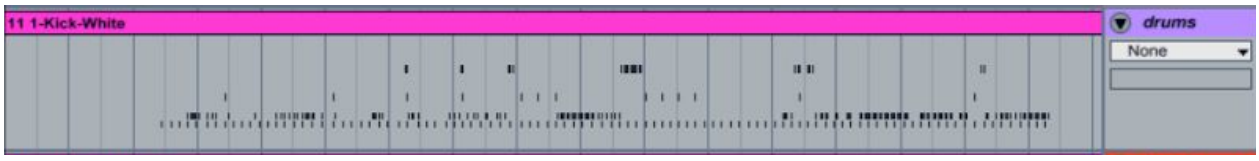

After


The chords at the beginning of the workshop were already dragged out in the right amount of time, however at the end of the workshop the participant started incorporating repetition into the chord scheme.

## Workshop three

**Drums**

Before

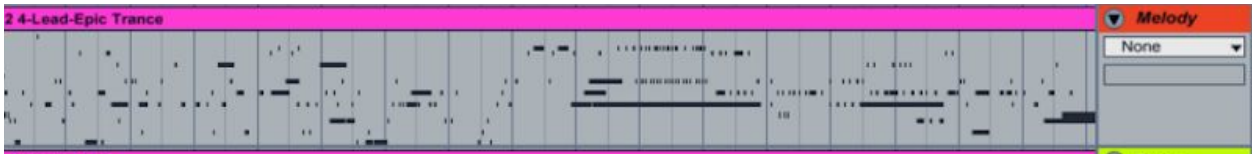



After

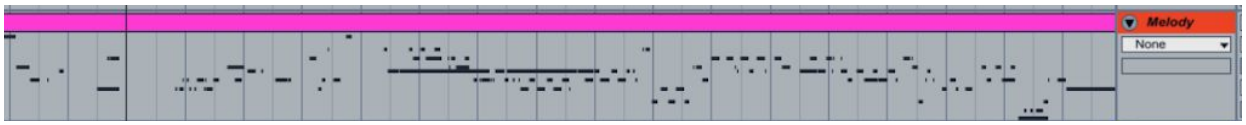
The drums have dramatically improved from the beginning to the end of the workshop. Where in the beginning it is almost not possible to identify a single groove, at the end this is clearly visible. Also the snare buildup has been performed successfully a few times.

**Melody**

Before




After




The melody has improved a bit. Especially at the beginning of the first session the notes are going all over the place without a clear pattern. At the end of the last session there is clearly a musical pattern visible.

**Bass**

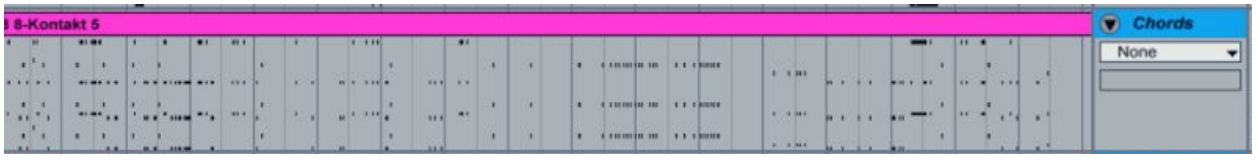
Before


After

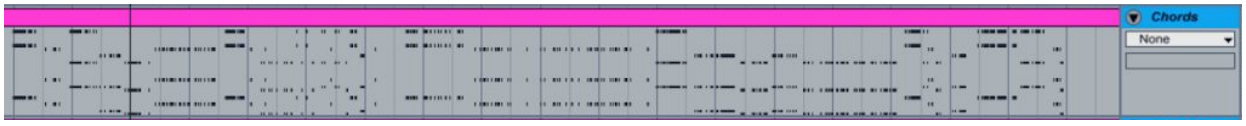

The bass has become a lot less messy. However now there are big gaps of silence in between. There is also no sign of repetition visible.

**Chords**

Before




After



The chords have definitely improved when talking about structure and repetition. However it is also visible that the chords are really glitchy. This might be the result of incorrectly pressing the buttons or a too high threshold value of the capacitive sensing.

## Survey

From the twenty surveys being filled out, the mean of each question has been calculated and is shown in table 7.3. The comments/tips did not reveal that many interesting things. Most of the comments were something positive about the workshop. The individual results and comments can be found in Appendix E.

| **Question** | **Mean (range 1 to 5)** |
|---|---:|
| How well did the instruments work? | 4.44 |
| What did you think of the quality of your music? | 4.11 |
| Did you find the topic of this workshop interesting? | 4.26 |
| Would you want to follow such a workshop again? | 4.26 |
| Would you like to make music more often? | 4.31 |
| Do you have the feeling that you learned something? | 4.08 |
| How well did you think music making with other people went? | 4.47 |

*Table 7.3: mean of score every question*

# VIII - Conclusion and further research

## 8.1 Conclusion

From the results can be derived that the workshops definitely were not completely unsuccessful. The two tests clearly show some kind of improvement and the survey also indicates that the children liked participating in the workshop. However it is not possible to immediately reject both null hypotheses. This is because of the following reasons.

The results for the test trying to reject the first null hypothesis, show that there is a 85% chance that the null hypothesis can be rejected, while this has to be at least 95% to confidently reject the null hypothesis. Also the ages of the test subjects had a broader range than initially was planned, this is because of the limited amount of children of the right age at the daycares. This broader range makes the differences between prior knowledge of the participants bigger, resulting in a less accurate comparison between the two groups. For further research this can be helped by using a bigger sample size and testing on children form about the same age.

The analysis on how well the participants were able to apply the different instruments shows a lot of improvement, however rejecting the second null hypothesis is also not that easy. This is because by just analyzing the MIDI information from the beginning and the end of the workshop it is not possible to compare the improvements to other forms of teaching about the same topic. This is why the results of this test can only prove that it it might be a good idea to do more research on this topic.

The survey can also only serve as a way to motivate further research. The results of this survey indicate that generally the children were positive about the workshop, but these results can not serve to statistically or academically prove that the workshop was a success. This is because the children were a bit biased because they knew that I designed and gave the workshop and might not want to hurt my feelings because of this.

From just analysing the behaviour of the children during the workshop a lot of useful information can be extracted by how well the workshop was received. It was interesting to see the process of how the children were discovering the functionality of each instrument how they were dealing with this. Looking at their interaction with each other and the system also revealed that the suspected communicative benefit of the system might be true. A couple of times the participants were making agreements with each other on who plays which button. For example, during one session, the children decided to first press the most left button together, afterwards the button next to it etc. From observing their behaviour it also became clear that the workshop should involve switching the instruments around. After every workshop, the children were very eager to try the other instruments as well. This indicates that the system is engaging enough for children to play with the system for the period of one workshop.

Also presenting at the conservatory gave already some positive confirmation about the usefulness of the system. While talking with a primary school music teacher who visited the presentations and tried the system out, she explained that letting children create modern sounding music has been a challenge for her and that she would gladly use one of these systems in her lessons. This can also serve as a motivation to continue further research.

So to answer the research question “How can technology effectively be used to get students familiar with and excited about music creation?”. A system that allows people to improvise modern music together might be effective enough to provide as an answer for this question. However there still is some more further research to be done in order to safely say so.

## 8.2 Further research

The results all indicate that doing further research on the usefulness and effectiveness of this workshop is a good idea. This can be done in the following ways.

**More controlled quiz**
Like mentioned in the conclusion, in order to confidently say that the workshop is an effective way to identify the functions of musical instruments, a bigger test is necessary. This test can be expanded by using a bigger testing group and making sure that the age range of test subjects is smaller. Creating a larger amount of questions could also create more reliable results.

**Quality of music**
The quality of the music in the current prototype has still a lot of room for improvement. The music being produced currently sounds a bit chaotic, while this will probably be inevitable when making music with children, the quality can still be enhanced by implementing a few things.

One of the things to improve is the implementation of dynamic control in the instruments. This can be achieved by for example implementing pressure sensors into the buttons. Creating dynamic control allows children to be more expressive in what they play, allowing the music to sound more like music.

Another way to improve the sound is to do more research into Ableton and how to choose the right instruments with effects. While I learned a lot about how to work with Ableton over the course of this project, I am still no expert, therefore there is still a lot of room for improvement in this field.

The choice of the musical notes is also something that can be improved. Especially the notes of the bass turned out to often not work very well. The use of the notes of the blues scale was a bit too difficult for children to comprehend, since these notes do not always sound right, but only when played in the right context. A solution to this is to reduce the amount of notes available for the bass and replace these for octaves (same notes but higher) of the notes that definitely work

well underneath each chord. There is also a lot of room for improvement in the drum loops. The drum loops were now created using timers in processing, this was not the most reliable and most efficient way to create drum loops. Triggering more complex drum loops from within Ableton would be something to look into for further research.

**Long term effects**

All the testing in this report has been done on a very short term basis, the quiz was held immediately after the workshop and the analysis of instrument application has been done during the workshop. However for a workshop to be a success it has to have long term benefits as well. One way to achieve this is by implementing the workshop in the lesson plan of music students and ask their teachers if they noticed any improvements after the workshop. Another way would be to ask the participants back a week after the initial workshop and ask them to again do some improvisation and look at improvements from the very first interaction with the system.

**Additional education benefits**

The testing done during this project is focused on participants being able to identify the different instrument functions and applying these. However like mentioned in chapter 4.2, there are some other expected benefits from this system as well. Examples of these are: Listening and communicating. Focussing and testing on these benefits might give some very interesting information about the system as well.

**Applications in music education**

When the workshop is definitely proven to be beneficial it is also necessary to do some research on how it can be implemented into current music education. This includes looking into if the workshop is more applicable for students of a music school, of a primary school or a secondary school. This choice also affects the lesson plan for the workshop, meaning the difficulty of exercises with the system depends on the age and musical ability of the participants. A study on the most effective age group, the appropriate lesson plan for this age group and how this system can be used in combination with the traditional method is therefore a good idea.

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# Appendix A - Lesson plan

Version 1.  Robin van Soelen
This plan provides an overview of the workshop, given with the use of four PentaSynth instruments.

**Learning goals**
The goal of the workshop is that afterwards, the student will be able to:

- To identify the four musical components of the pentasynth which play a role in current days music
- To apply these components in an effective way within a song
- To be able to play music together

These goals are being achieved by completing the excercises treated in this plan.

PART I: The Introduction

**Information**: “Listen to this dance song. Which instruments do you hear? Today you are going to make similar music. But your bandname is xxx and you are going to write something even better”
**Instruction:** “Try the instruments out and try to make music with them.
**Expected result**: Participants tried out the system and realise the result is not that great yet
**Learning goal:** Learn what the system does and realise they need some additional information.
**Time:** ~4 minutes

**In between**: Explain how the pentasystem works

PART II: The Chords

**Information**: “Chords are multiple notes played at the same time. Chords create structure in a song. In pop music there are often four chords or less in a row which will be repeated continuously.”
**Instruction**: “Try out the chords and choose four chords and repeat them.”
**Expected result**: Found four chords and is playing these continuously .
**Learning goal:** Get an idea of what a chord is and how to use multiple chords together.
**Time**: ~4 minutes

PART IIIa: The Drums (playing in rythm)

**Information**: “In music everyone plays in the same tempo, this tempo is being set by the drums. The rythm of music is almost always counted in 4.”

**Instruction**: “Press most left button on drummachine and let the chords play along with the drums and change every four counts.”
**Expected result**: The chords and the drums are playing in time.
**Learning goal:** Learn how to play in rythm.
**Time**: ~2 minutes

PART IV: The Bass

**Information**: “The bass plays low notes. The bass provides the rythmic and harmonic foundation of a song.“
**Instruction**: The bass often plays the root note of a chord, which is the most left button on the PentaSynth. Try pressing this button on the beat of the music.”
Or
“Try the buttons out and listen which button sounds right underneath the chords”
**Expected result:** The participant is playing the bass in the rythm of the music.
**Learning goal:** Realise what the function of a bass guitar is and how to apply it in music.
**Time**: ~4 minutes

PART V: The Melody

**Information**: The melody is the bit of the music you often remember. It sort of floats over the other parts of the music.
**Instruction**: Throw two dices and play those two notes in the a random order and try to make a melody
**Expected result:** They tried out several things and found a melody that works.
**Learning goal:** Learn what a melody is and how to make one.
**Time**: ~6 minutes

PART IIIb: The Drums (the buildup)

**Information**: In dance music a lot of use is being made of buildups and drops. This is often guided with the use of drums.
**Instruction**: Use the most right two buttons to create a buildup
**Expected result**: The particpants applied buildup.
**Learning goal:** Learn about dynamic changes in a song and how to apply these
**Time**: ~2 minutes

PART VI: The epic improvisation

**Information**:
**Instruction**: I am now going to record what you’re doing, so try to make something nice.
**Expected result**: They made music and and it was amazing
**Learning goal:** Apply learned knowledge and have fun
**Time**: ~5/10 minutes

# Appendix B - Survey PentaSynth

Versie 1. User test Kaliber

**Welk kastje speelt meerdere noten tegelijk?**

- Chords / Akkoorden
- Drums
- Melodie
- Bass

**Welk kastje speelt de lage noten?**

- Bass
- Chords / Akkoorden
- Drums
- Melodie

**Welk kastje speelt het ritme?**

- Bass
- Chords / Akkoorden
- Drums
- Melodie

**Wat vond je van de kwaliteit van je muziek?**

| Verschrikkelijk | | | | Super |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**Wat vond je van de kwaliteit van de instrumenten?**

| Werkte niet | | | | Werkte goed |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**Zou je deze workshop nog een keer willen volgen?**

| Absoluut niet | | | | lijkt me leuk |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**Heb je het gevoel dat je wat geleerd hebt?**

| Nee | | | | Jazeker |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**Snap je nu beter waaruit muziek is opgebouwd?**

| Nee | | | | Jazeker |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**Heb je verder nog tips/suggesties?**

……
……
……
……...

# Appendix C - Only theory lesson plan

The goal of this lesson is to explain the four functions of musical instruments.This will be done by explaining the following:

Musical instruments have different functions which can be grouped into four different ones

*Drums*
Drums provide the rhythmic support for a song. Drums are a tool to explain to the listener what the beat is and where the accents of a song lie.

*Chords*
Chords are multiple notes played at the same time. Chords provide the harmonic structure in a song.

*Bass*
The bass are the low notes in a song which make tables vibrate. They provide the foundation for the rest of the harmony to built on to

*Melody*
The melody is the more high pitched sound which plays the part of the song that gets stuck in your head the next day.

# Appendix D - Evaluation quiz

Jullie gaan zometeen 10 geluidsfragmenten horen, geef aan of je A. De bas, B. De melodie, C De drum of D. De akkoorden hoort.

Geluidsfragment 1
A. De bas
B. De melodie
C. De drum
D. De akkoorden

Geluidsfragment 2
A. De bas
B. De melodie
C. De drum
D. De akkoorden

Geluidsfragment 3
A. De bas
B. De melodie
C. De drum
D. De akkoorden

Geluidsfragment 4
A. De bas
B. De melodie
C. De drum
D. De akkoorden

Luister nu hoe het samen klinkt

Geluidsfragment 5
A. De bas
B. De melodie
C. De drum
D. De akkoorden

Geluidsfragment 6
A. De bas
B. De melodie
C. De drum
D. De akkoorden

Geluidsfragment 7

A. De bas
B. De melodie
C. De drum
D. De akkoorden

Geluidsfragment 8

A. De bas
B. De melodie
C. De drum
D. De akkoorden

Luister nu hoe het samen klinkt

Bij de volgende twee fragmenten hoor je twee instrumenten tegelijk. Geef aan welke TWEE je hoort.

Geluidsfragment 9

A. De bas
B. De melodie
C. De drum
D. De akkoorden

Geluidsfragment 10

A. De bas
B. De melodie
C. De drum
D. De akkoorden

# Appendix E - Results survey

| **Questions** | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| How well did the instruments work? | 4 | 4 | 5 | 4 | | 4 | 4 | 5 | 4 | 5 | 4 | 5 | 4 | 5 | 4 | 4 | 5 | 5 | 5 |
| What did you think of the quality of your music? | 5 | 1 | 3 | 2 | 4 | 5 | 4 | 5 | 5 | 5 | 5 | 3 | 5 | 5 | 5 | 4 | 4 | 4 | 4 |
| Did you find the topic of this workshop interesting? | 5 | 5 | 5 | 5 | 5 | 4.5 | 3.5 | 4 | 5 | 5 | 2 | 4 | 2 | 5 | 5 | 5 | 4 | 3 | 4 |
| Would you want to follow such a workshop again? | 5 | 5 | 2 | 4 | 5 | 4.5 | 3.5 | 5 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 3 | 3 |
| Would you like to make music more often? | 5 | 5 | | 3 | 5 | 4 | 1.5 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 4 | 5 | 5 | 2 |
| Do you have the feeling that you learned something? | 5 | 3 | 4 | 5 | 4 | 5 | 2.5 | 4 | 4 | 5 | 1 | 3 | 5 | 5 | 5 | 4 | 4 | 4 | 5 |
| How well did you think music making with other people went? | 4 | 5 | 5 | 4 | 5 | 3 | 3 | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 5 | 5 | 3 | 5 | 5 |

# Appendix F - Arduino code

```
#include <CapacitiveSensor.h>
char val;
char oldVal;
long total1;
long total2;
long total3;
long total4;
long total5;

CapacitiveSensor   cs_2_4 = CapacitiveSensor(2, 4);       // 10 megohm resistor between pins 4 & 2, pin 2 is sensor pin, add wire,
foil
CapacitiveSensor   cs_2_6 = CapacitiveSensor(2, 6);       // 10 megohm resistor between pins 4 & 2, pin 2 is sensor pin, add wire,
foil
CapacitiveSensor   cs_2_8 = CapacitiveSensor(2, 8);       // 10 megohm resistor between pins 4 & 2, pin 2 is sensor pin, add wire,
foil
CapacitiveSensor   cs_2_10 = CapacitiveSensor(2, 10);       // 10 megohm resistor between pins 4 & 2, pin 2 is sensor pin, add wire,
foil
CapacitiveSensor   cs_2_12 = CapacitiveSensor(2, 12);       // 10 megohm resistor between pins 4 & 2, pin 2 is sensor pin, add wire,
foil

void setup()
{
  cs_4_2.set_CS_AutocaL_Millis(0xFFFFFFFF);     // turn off autocalibrate on channel 1 - just as an example
  Serial.begin(115200);
}

void loop()
{
  long start = millis();
  total1 =  cs_2_4.capacitiveSensor(30);
  total2 =  cs_2_6.capacitiveSensor(30);
  total3 =  cs_2_8.capacitiveSensor(30);
  total4 =  cs_2_10.capacitiveSensor(30);
  total5 =  cs_2_12.capacitiveSensor(30);

  if (total1 > 10000) {
    val = '1';
  }
  else if (total2 > 10000) {
    val = '2';
  }
  else if (total3 > 10000) {
    val = '3';
  }else if (total4 > 10000) {
    val = '4';
  }else if (total5 > 10000) {
    val = '5';
  }
  else val = '0';

  if (val != oldVal) {
    Serial.print(val);
  }
  oldVal = val;
}
```

# Appendix G: Processing code

```
import themidibus.*; //Import the library
import processing.serial.*;


Serial chordPort;
Serial melodyPort;
Serial bassPort;
Serial drumPort;

PFont mainFont;
color buttons = #8D2793;


MidiBus myChordBus; // The MidiBus
MidiBus myMelodyBus; // The MidiBus
MidiBus myDrumBus;
MidiBus myBassBus;

int noteNumber = 0;
boolean once = true;
String val;
String pval;
int pvalue;
int count = 0;
int[] Cmaj = {48, 55, 64};
int[] emin = {40, 55, 47};
int[] Fmaj = {41, 48, 57};
int[] Gmaj = {43, 59, 50};
int[] amin = {45, 60, 64};

int[][] melodyNotes =
  {{60, 62, 64, 67, 69}, // c,d,e,g,a
  {60, 62, 64, 67, 69}, //c,d,e,g,a
  {64, 67, 69, 71, 74 }, //e,g,a,b,d
  {65, 67, 69, 72, 74}, //f,g,a,c,d
  {67, 69, 71, 76, 77}, //g,a,b,e,f
  {69, 72, 74, 76, 79}}; //a, c,d,e,g
//int[][] melodyNotes =    //pentatonic highest note a
//  {{48, 50, 52, 55, 57},
//  {48, 50, 52, 55, 57},
//  {47, 50, 52, 55, 57},
//  {48, 50, 53, 55, 57},
//  {47, 50, 52, 55, 57},
//  {48, 50, 52, 55, 57}};

int[][] bassNotes =
  {{36, 40, 43, 45, 46},
  {36, 40, 43, 45, 46},
  {40, 43, 47, 48, 50},
  {41, 45, 48, 50, 51},
  {43, 47, 50, 52, 53},
  {45, 48, 52, 53, 55}};

int oldPitch1;
int oldPitch2;
int oldPitch3;
int oldPitch;
int pitch = 0;

int instrCount = 0;
int melCount = 0;
int bassCount = 0;

long oldEightMillis;
long oldFourthMillis;

int channel = 0;

char drumNote = '0';

void setup() {
  // size(400, 400);
  fullScreen();
  background(0);

  MidiBus.list(); // List all available Midi devices on STDOUT. This will show each device's index and name.

  myMelodyBus = new MidiBus(this, -1, 11);
  myDrumBus = new MidiBus(this, -1, 15);
```

```
  myBassBus = new MidiBus(this, -1, 3);
  myChordBus = new MidiBus(this, -1, 7);// Create a new MidiBus with no input device and the default Java Sound Synthesizer as the output device.

  //println(Serial.list()[0]);
  //String portName = Serial.list()[0]; //change the 0 to a 1 or 2 etc. to match your port
  //String portName4 = Serial.list()[2]; //change the 0 to a 1 or 2 etc. to match your port
  //String portName3 = Serial.list()[1]; //change the 0 to a 1 or 2 etc. to match your port
  //String portName2 = Serial.list()[3]; //change the 0 to a 1 or 2 etc. to match your port

  //chordPort = new Serial(this, portName3, 115200);
  //melodyPort = new Serial(this, portName, 115200);
  //bassPort = new Serial(this, portName2, 9600);
  //drumPort = new Serial(this, portName, 115200);
}
void draw() {
  background(#9EEDFC);
  //melody(chordSynth());
  //bass(chordSynth());
  drumSynth();
  drawInstrument('1', 0, 0);
  drawInstrument('0', 1, 0);
  drawInstrument('3', 2, 0);
  drawInstrument('5', 3, 0);
  noStroke();
}
void delay(int time) {
  int current = millis();
  while (millis () < current+time) Thread.yield();
}
void bass(int chord) {
  int velocity = 127;
  char mote = ' ';
  if (bassPort.available()>0) {
    char note = '0';
    note = bassPort.readChar();
    mote = note;
    println(note);
    for (int j=0; j<6; j++) {
      if (chord == j) {
        if (note == '1') {
          pitch = bassNotes[j][0];
        }
        if (note == '2') {
          pitch = bassNotes[j][1];
        }
        if (note == '3') {
          pitch = bassNotes[j][2];
        }
        if (note == '4') {
          pitch = bassNotes[j][3];
        }
        if (note == '5') {
          pitch = bassNotes[j][4];
        }
        if (note == '4') {
          pitch = bassNotes[j][3];
        }
        if (note == '3') {
          pitch = bassNotes[j][2];
        }
        if (note == '2') {
          pitch = bassNotes[j][1];
        }
        if (note == '1') {
          pitch = bassNotes[j][0];
        }
      }
    }
    if (note == '0') {
      pitch = oldPitch;
    }
    Note note13 = new Note(channel, pitch, velocity);
    if (note == '1' || note == '2' || note == '3' || note == '4' || note == '5') {
      myBassBus.sendNoteOn(note13);
    } else {
      myBassBus.sendNoteOff(note13); // Send a Midi nodeOff
    }

    if (oldPitch != pitch && note!='0') {
      Note oldNote13 = new Note(channel, oldPitch, velocity);
      myBassBus.sendNoteOff(oldNote13); // Send a Midi nodeOff
    }
  }
  drawInstrument(mote, 3, 50);
  oldPitch = pitch;
  melodyPort.clear();
```

```
}
int chordSynth() {
  char note;
  char mote = ' ';
  int pitch1 = 0;
  int pitch2 = 0;
  int pitch3 = 0;
  int velocity;
  note = '0';
  if (chordPort.available()>0) {
    note = chordPort.readChar();
    mote = note;
    velocity = 127;
    pitch1 = 36;
    if (note == '1') {
      pitch1 = Cmaj[0];
      pitch2 = Cmaj[1];
      pitch3 = Cmaj[2];
      noteNumber = 1;
    }
    if (note == '2') {
      pitch1 = emin[0];
      pitch2 = emin[1];
      pitch3 = emin[2];
      noteNumber = 2;
    }
    if (note == '3') {
      pitch1 = Fmaj[0];
      pitch2 = Fmaj[1];
      pitch3 = Fmaj[2];
      noteNumber = 3;
    }
    if (note =='4') {
      pitch1 = Gmaj[0];
      pitch2 = Gmaj[1];
      pitch3 = Gmaj[2];
      noteNumber = 4;
    }

    if (note == '5') {
      pitch1 = amin[0];
      pitch2 = amin[1];
      pitch3 = amin[2];
      noteNumber = 5;
    }

    if (note == '0') {
      pitch1 = oldPitch1;
      pitch2 = oldPitch2;
      pitch3 = oldPitch3;
    }
    Note note1 = new Note(channel, pitch1, velocity);
    Note note2 = new Note(channel, pitch2, velocity);
    Note note3 = new Note(channel, pitch3, velocity);
    if (note == '6') {
      instrCount--;
      if (instrCount == -1) instrCount = 3;
      myChordBus = new MidiBus(this, -1, 7+instrCount);// Create a new MidiBus with no input device and the default Java Sound Synthesizer as the output device.
      myChordBus.sendNoteOff(note1); // Send a Midi nodeOff
      myChordBus.sendNoteOff(note2); // Send a Midi nodeOff
      myChordBus.sendNoteOff(note3); // Send a Midi nodeOff
    }
    if (note == '7') {
      instrCount++;
      if (instrCount >3) instrCount = 0;
      myChordBus = new MidiBus(this, -1, 7+instrCount);// Create a new MidiBus with no input device and the default Java Sound Synthesizer as the output device.
      myChordBus.sendNoteOff(note1); // Send a Midi nodeOff
      myChordBus.sendNoteOff(note2); // Send a Midi nodeOff
      myChordBus.sendNoteOff(note3); // Send a Midi nodeOff
    }
    if (note == '1' || note == '2' || note == '3' || note == '4' || note == '5' ) {
      myChordBus.sendNoteOn(note1); // Send a Midi noteOn
      myChordBus.sendNoteOn(note2); // Send a Midi noteOn
      myChordBus.sendNoteOn(note3); // Send a Midi noteOn
    } else {
      myChordBus.sendNoteOff(note1); // Send a Midi nodeOff
      myChordBus.sendNoteOff(note2); // Send a Midi nodeOff
      myChordBus.sendNoteOff(note3); // Send a Midi nodeOff
    }
    if (oldPitch1 != pitch1) {
      Note oldNote1 = new Note(channel, oldPitch1, velocity);
      Note oldNote2 = new Note(channel, oldPitch2, velocity);
      Note oldNote3 = new Note(channel, oldPitch3, velocity);

      myChordBus.sendNoteOff(oldNote1); // Send a Midi nodeOff
      myChordBus.sendNoteOff(oldNote2); // Send a Midi nodeOff
```

```
      myChordBus.sendNoteOff(oldNote3); // Send a Midi nodeOff
    }
    oldPitch1 = pitch1;
    oldPitch2 = pitch2;
    oldPitch3 = pitch3;
    //int number = 0;
    //int value = 90;
    //ControlChange change = new ControlChange(channel, mouseX, mouseX);
    //myChordBus.sendControllerChange(change); // Send a controllerChange
    chordPort.clear();
  }
  // }
  drawInstrument(mote, 1, noteNumber);
  return noteNumber;
}
void drumSynth() {
  //if (drumPort.available()>0) {
  //  char tempNote = drumPort.readChar();
  //  if (tempNote != '0') drumNote = tempNote;
  //}
  if (keyPressed) {
      if (key == '1') drumNote = '1';
      if (key == '2') drumNote = '2';
      if (key == '3') drumNote = '3';
      if (key == '4') drumNote = '4';
      if (key == '5') drumNote = '5';
    }
  if (drumNote == '5') {
    drumNoteOne();
  }
  if (drumNote == '4') drumNoteTwo();
  if (drumNote == '3') drumNoteThree();
  if (drumNote == '2') drumNoteFour();
  if (drumNote == '1') drumNoteFive();

  if (count >4){
    count = 1;
  }
  mainFont = createFont("Arial", 500);
  textFont(mainFont);
  fill(255);
  if (drumNote != '0') text(count,height/2+250,height/2+150);
  drawInstrument(drumNote, 0, 50);
}
void drumNoteOne() {
  long fourthMillis = millis();
  long eightMillis = millis();
  Note kick = new Note(0, 36, 127);
  Note hat = new Note(0, 42, 127);
  Note clap = new Note(0, 39, 127);
  if (eightMillis>oldEightMillis +250) {
    oldEightMillis = eightMillis;
    if (fourthMillis > oldFourthMillis + 500) {
      count++;
      myDrumBus.sendNoteOn(kick);
      myDrumBus.sendNoteOff(kick);
      oldFourthMillis = fourthMillis;
      //if (once) {
      //  myDrumBus.senddrumNoteOn(clap);
      //  myDrumBus.senddrumNoteOff(clap);
      //  once = false;
      //} else once = true;
      // }
    }
  }
}

void drumNoteTwo() {
  long fourthMillis = millis();
  long eightMillis = millis();
  Note kick = new Note(0, 36, 127);
  Note hat = new Note(0, 42, 127);
  Note clap = new Note(0, 39, 127);
  if (eightMillis>oldEightMillis +250) {
    oldEightMillis = eightMillis;
    if (fourthMillis > oldFourthMillis + 500) {
      myDrumBus.sendNoteOn(kick);
      count++;
      myDrumBus.sendNoteOff(kick);
      oldFourthMillis = fourthMillis;
      if (once && (count == 2 || count == 4)) {
        myDrumBus.sendNoteOn(clap);
        myDrumBus.sendNoteOff(clap);
        once = false;
      } else once = true;
    }
```

```
  }
}
void drumNoteThree() {
  long fourthMillis = millis();
  long eightMillis = millis();
  Note kick = new Note(0, 36, 127);
  Note hat = new Note(0, 42, 127);
  Note clap = new Note(0, 39, 127);
  if (eightMillis>oldEightMillis +250) {
    myDrumBus.sendNoteOn(hat);
    myDrumBus.sendNoteOff(hat);
    oldEightMillis = eightMillis;
    if (fourthMillis > oldFourthMillis + 500) {
      myDrumBus.sendNoteOn(kick);
      count++;
      myDrumBus.sendNoteOff(kick);
      oldFourthMillis = fourthMillis;
      if (once && (count == 2 || count == 4)) {
        myDrumBus.sendNoteOn(clap);
        myDrumBus.sendNoteOff(clap);
        once = false;
      } else once = true;
    }
  }
}
void drumNoteFour() {
  long fourthMillis = millis();
  long eightMillis = millis();

  Note kick = new Note(0, 36, 127);
  Note hat = new Note(0, 42, 127);
  Note snare = new Note(0, 37, 127);

  if (eightMillis>oldEightMillis +250) {
    myDrumBus.sendNoteOn(snare);
    myDrumBus.sendNoteOff(snare);
    oldEightMillis = eightMillis;
    if (fourthMillis > oldFourthMillis + 500) {
      myDrumBus.sendNoteOn(kick);
      count++;
      myDrumBus.sendNoteOff(kick);
      oldFourthMillis = fourthMillis;
      //if (once) {
      //  myDrumBus.sendNoteOn(clap);
      //  myDrumBus.sendNoteOff(clap);
      //  once = false;
      //} else once = true;
    }
  }
}
void drumNoteFive() {
  long fourthMillis = millis();
  long eightMillis = millis();

  Note kick = new Note(0, 36, 127);
  Note hat = new Note(0, 42, 127);
  Note snare = new Note(0, 37, 127);

  if (eightMillis>oldEightMillis +125) {
    myDrumBus.sendNoteOn(snare);
    myDrumBus.sendNoteOff(snare);
    oldEightMillis = eightMillis;
    if (fourthMillis > oldFourthMillis + 500) {
      myDrumBus.sendNoteOn(kick);
      count++;
      myDrumBus.sendNoteOff(kick);
      oldFourthMillis = fourthMillis;
      //if (once) {
      //  myDrumBus.sendNoteOn(clap);
      //  myDrumBus.sendNoteOff(clap);
      //  once = false;
      //} else once = true;
    }
  }
}
void melody(int chord) {
  int velocity = 127;
  char mote = ' ';
  char note = '0';

  if (melodyPort.available()>0) {
    note = melodyPort.readChar();

    mote = note;
    println(mote);
    for (int j=0; j<6; j++) {
```

```
      if (chord == j) {
        if (note == '5') {
          pitch = melodyNotes[j][4];
        }
        if (note == '4') {
          pitch = melodyNotes[j][3];
        }
        if (note == '3') {
          pitch = melodyNotes[j][2];
        }
        if (note == '2') {
          pitch = melodyNotes[j][1];
        }
        if (note == '1') {
          pitch = melodyNotes[j][0];
        }
      }
    }
    if (note == '0') {
      pitch = oldPitch;
    }


    Note note13 = new Note(channel, pitch, velocity);

    if (note == '6') {
      melCount--;
      if (melCount == -1) instrCount = 3;
      myMelodyBus = new MidiBus(this, -1, 11+melCount);// Create a new MidiBus with no input device and the default Java Sound Synthesizer as the output device.
      myMelodyBus.sendNoteOff(note13); // Send a Midi nodeOff
    }
    if (note == '7') {
      melCount++;
      if (melCount >3) melCount = 0;
      myMelodyBus = new MidiBus(this, -1, 11+melCount);// Create a new MidiBus with no input device and the default Java Sound Synthesizer as the output device.
      myMelodyBus.sendNoteOff(note13); // Send a Midi nodeOff
    }
    if (note == '1' || note == '2' || note == '3' || note == '4' || note == '5') {
      myMelodyBus.sendNoteOn(note13);
    } else {

      myMelodyBus.sendNoteOff(note13); // Send a Midi nodeOff
    }

    if (oldPitch != pitch && note!='0') {
      Note oldNote13 = new Note(channel, oldPitch, velocity);
      myMelodyBus.sendNoteOff(oldNote13); // Send a Midi nodeOff

      //for (int j=0; j<6; j++) {
      //  for (int i=0; i<5; i++) {
      //    pitch = melodyNotes[j][i];
      //    Note oldNote = new Note(channel, oldPitch, velocity);

      //    myMelodyBus.sendNoteOff(oldNote); // Send a Midi nodeOff
      //  }
      //}
    }
  }
  drawInstrument(mote, 2, 50);
  oldPitch = pitch;
  melodyPort.clear();
}
void drawInstrument (char number, int instrument, int cumber) { //0 = drum 1=chords 2=melody 3 = bass
  textSize(50);
  int Xloc=0;
  int Yloc=0;
  if (instrument == 0) {
    Xloc = 0;
    Yloc = 140;
  }
  if (instrument == 1) {
    Xloc = 1250;
    Yloc = 140;
  }

  if (instrument == 2) {
    Xloc = 0;
    Yloc = height - 150;
  }

  if (instrument == 3) {
    Xloc = 1250;
    Yloc = height - 150;
  }
  fill(#FFFBDB);
  rect(Xloc + 87, Yloc-100, 500, 200);
```

```
  int mumber = 0;
  mumber = cumber;
  //if (instrument == 2) {
  //  if (number == '1') mumber = 5;
  //  if (number == '2') mumber = 4;
  //  if (number == '3') mumber = 3;
  //  if (number == '4') mumber = 2;
  //  if (number == '5') mumber = 1;
  //} else {
    if (number == '1') mumber = 1;
    if (number == '2') mumber = 2;
    if (number == '3') mumber = 3;
    if (number == '4') mumber = 4;
    if (number == '5') mumber = 5;
 // }
  if (number == '0') mumber = 0;
  if (cumber == 1) buttons = #D60F12;
  if (cumber == 2) buttons = #180D93;
  if (cumber == 3) buttons = #8D2793;
  if (cumber == 4) buttons = #2C5806;
  if (cumber == 5) buttons = #04DEBF;
  for (int i=1; i<6; i++) {
    if (i==mumber) {
      fill(buttons);
    } else {
      fill (255);
    }
    rect(Xloc + i*100, Yloc, 75, 75);
  }
  fill(100);
  if (instrument == 0) text("drums.", 410, 110);
  if (instrument == 1) text("chords.", Xloc + 410, Yloc -30);
  if (instrument == 2) text("melody.", Xloc + 410, Yloc -30);
  if (instrument == 3) text("bass.", Xloc + 440, Yloc -30);
}
```